INSTRUCTION MANUAL

MODEL 1402
SWEEP GENERATOR

WAVETEK® INDIANA INC.

66 N. 1ST AVENUE, P.O. BOX 190
BEECH GROVE, INDIANA 46107
317—783-3221

PRELIMINARY

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WARRANTY

All Wavetek instruments are warranteed against defects in material and workmanship for a period of one year after date of manufacture. Wavetek agrees to repair or replace any assembly or component (except batteries) found to be defective, under normal use during this period. Transfermatic Switch assemblies, manufactured by Wavetek, are unconditionally warranteed for the life of the instrument. Wavetek's obligation under this warranty is limited solely to repairing any such instrument which in Wavetek's sole opinion proves to be defective within the scope of the warranty when returned to the factory or to an authorized service center. Transportation to the factory or service center is to be prepaid by purchaser. Shipment should not be made without prior authorization by Wavetek.

This warranty does not apply to any products repaired or altered by persons not authorized by Wavetek, or not in accordance with instructions furnished by Wavetek. If the instrument is defective as a result of misuse, improper repair, or abnormal conditions or operations, repairs will be billed at cost.

Wavetek assumes no responsibility for its product being used in a hazardous or dangerous manner either alone or in conjunction with other equipment. High voltage used in some instruments may be dangerous if misused. Special disclaimers apply to these instruments. Wavetek assumes no liability for secondary charges or consequential damages and, in any event, Wavetek's liability for breach of warranty under any contract or otherwise, shall not exceed the purchase price of the specific instrument shipped and against which a claim is made.

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1.1 INTRODUCTION

The Model 1402 is an all-solid-state electronically swept and tuned VHF Sweep/Marker Generator, covering the 40 to 400 MHz range. Center frequency and markers are controlled by a 36 position program switch providing audio and video carrier markers at IF (channel 1), TV channels 2 through 13, and the CATV channels A through W. It is designed for the testing and aligning of VHF television tuners and receivers and of CATV converters and "head-end" equipment.

The RF marker system is unique in that it provides 72 IF and RF carrier markers, while using only 13 crystals. The markers consist of sharp positive or negative going pulse sufficient in amplitude for oscilloscope intensity modulation available at a rear panel connector, and/or negative going differentiated pulses added internally to the demodulated envelope.

An important feature of the 1402 is its ability to be remotely controlled and programmed. This enables the sweep generator to be sequenced to the test procedure with pushbutton switches instead of manual tuning and adjustments. Also, the channel switch assembly can be quickly disconnected so that it may be removed from the instrument, extended, and remotely located at the tuner or receiver test fixture.

The instruments most outstanding option is that of automatic level operation. Simply stated, in automatic level operation the sweep generator RF output level is automatically adjusted to follow the variations of the tuner, or receiver while maintaining a constant one volt pattern on the oscilloscope display. A baseline pedestal in the display indicates the RF output level. This provides considerable time saving during the alignment procedure. The option includes a differentiated pulse that provides a center frequency indication directly on the oscilloscope tube.

Another option is up to five additional markers in the IF (channel 1) position. These are sharp positive or negative going pulses available at the rear panel, or negative differentiated pulses internally modulating the demodulated envelope and are derived from plug-in crystal filters.

Other options provided are; local oscillator tracking markers and a 12 VHF TV channel switch assembly (IF and Broadcast 2 to 13) in place of the 35 channel switch.

All optional features, as well as the circuits for the basic sweep generator, have plug-in modular construction. This allows optional features to be factory installed at the time of purchase, or customer installed at a later date. This concept offers protection against obsolescence since updated and additional features can be simply and economically added as new tuner designs and test procedures dictate.

Maintenance problems can be greatly simplified by the stocking of several modules instead of hundreds of discrete parts. Servicing time of a defective instrument can be cut to a fraction of the time previously required and can be performed by relatively inexperienced technicians.

SECTION 2
INSTALLATION

2.1 MECHANICAL INSTALLATION

2.1.1 Initial Inspection

After unpacking the instrument, visually inspect the external parts for damage to knobs, connectors, surface areas, etc. The shipping container and packing material should be saved in case it is necessary to reship the unit.

2.1.2 Damage Claims

If the instrument is received mechanically damaged in transit, notify the carrier and either the nearest Wavetek area representative or the factory in Indiana. Retain the shipping carton and packing material for the carrier's inspection.

The local representative, or the factory, will immediately arrange for either the replacement or repair of your instrument, without waiting for damage claim settlements.

2.1.3 Rack Mounting

The instrument is 1/2 rack size and two rack mounting kits are available. The K-103 kit provides the necessary hardware to mount the unit to either the right or left of a standard 5¼" x 19" opening. The K-104 kit provides the necessary hardware to rack mount two instruments. These may be two 1000 or 2000 series Wavetek, Indiana Instruments, or two 130 or 140 series Wavetek, San Diego Instruments, or a combination of either. This provides a 7" x 19" package. Facilities are provided for Front Panel mounting of instrument Rear Panel connectors.

2.1.4 K-103, Rack Mounting Kit (Refer to Figure 2-1)

CONTENTS

Item	Qty.	Part No.
A (Side)	1 ea.	B000-608
B (Side)	1 ea.	C000-610
C (Screw)	8 ea.	HS101-806

Procedure:

Remove the screws from one side panel at a time. Mount item A or B against the side panel of the instrument and secure with screws provided (item C). Repeat operation for other side. NOTE: Items A & B may be interchanged to position the unit to the side of the rack desired.

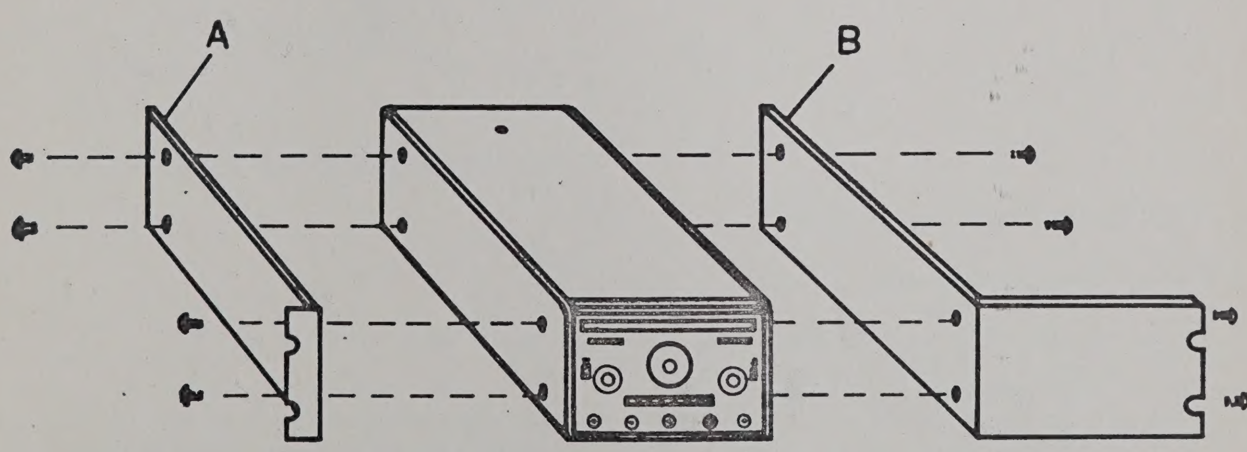


Figure 2-1. K-103 Rack Mounting

2.1.5 K-104 Rack Mounting Kit (Refer to Figure 2-2)

CONTENTS

Item	Qty.	Part No.
A (Tray)	2 ea.	C000-729
B (Side)	2 ea.	A500-230
C (Screw)	12 ea.	HS101-905

Procedure:

Install both sides (item B) to one tray (item A) using 10-32 x 3/16" screws (item C). Position the instrument on the tray so that the feet extend into the provided holes. Holes are provided for all Wavetek, Indiana 1000 and 2000 series and for most Wavetek, San Diego 130, 140, and 700 series instruments. Other instruments not exceeding 5¼" x 8" may also be mounted by drilling additional holes for their feet.

When one or both instruments are properly seated, install the other item "A" and secure with the remaining screws (item C).

NOTE: If the Wavetek instrument has been supplied with a bail, it must be removed before installing in the K-104 rack mounting kit.

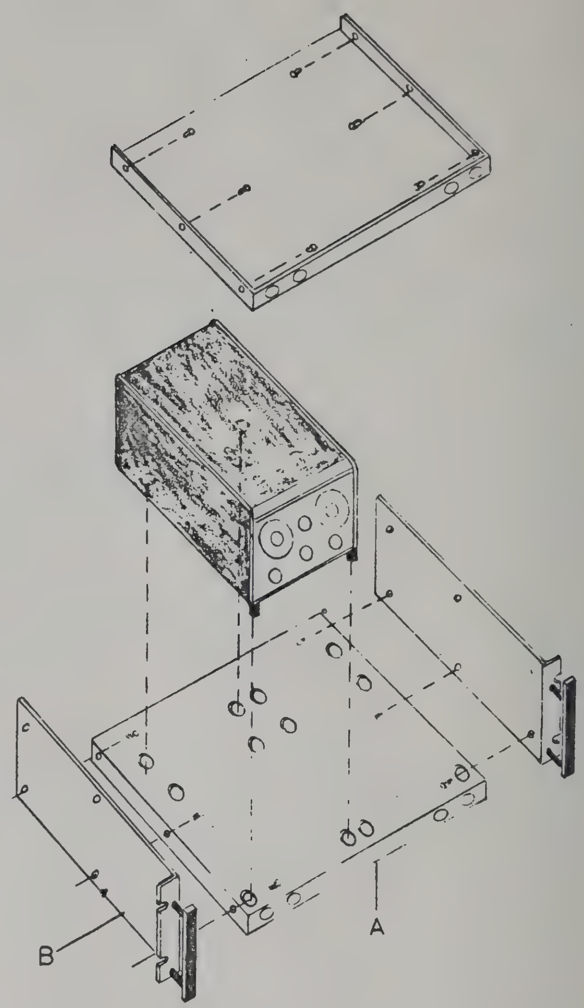


Figure 2-2. K-104 Rack Mounting

2.2 ELECTRICAL INSTALLATION

2.2.1 Primary Power Requirements

These instruments operate from either 115 volt AC or 230 volt AC supply mains as selected by a Slide Switch located on the Rear Panel. Before operating the instrument, check that the fuse mounted in the Rear Panel Fuse Holder corresponds to the correct value for the selected voltage, i.e., 0.5 amp for a 115 volt AC, and 0.25 amp for 230 volt AC.

The power supply has been designed to operate from either 50 or 60 Hz supply mains.

Instruments are shipped from the factory for operation at 115 volt AC, 60 Hz unless specified for 230 volt AC

2.2.2 Performance Checks

The electrical performance of this instrument should be verified. Performance checks for incoming inspection are given in Section 5, Maintenance.

SECTION 3
OPERATING INSTRUCTIONS

3.1 INTRODUCTION

This section provides complete functional control description, operating instructions, and programming instructions for the Model 1402 Sweep Generator.

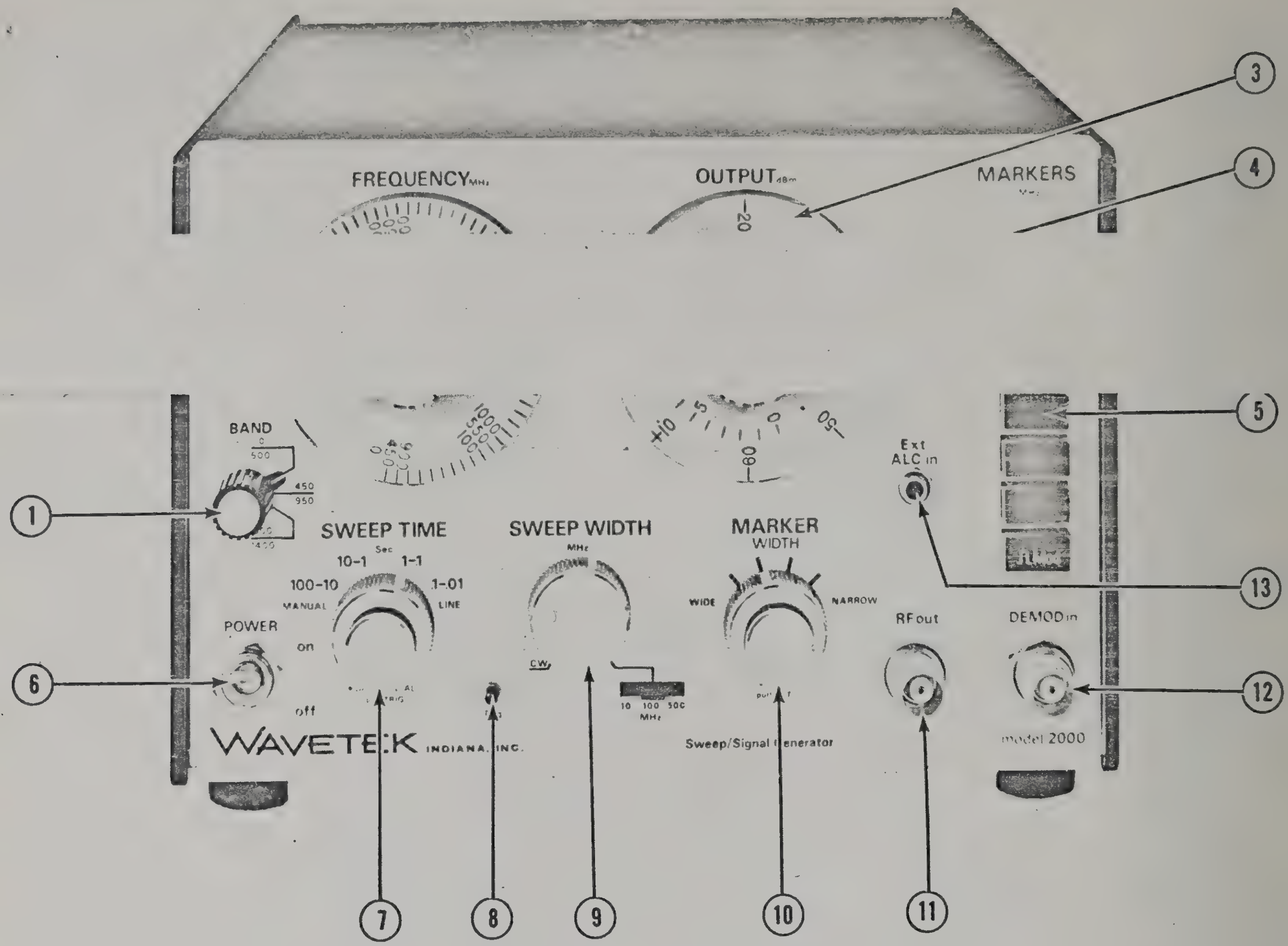


Figure 3-1. Front Panel

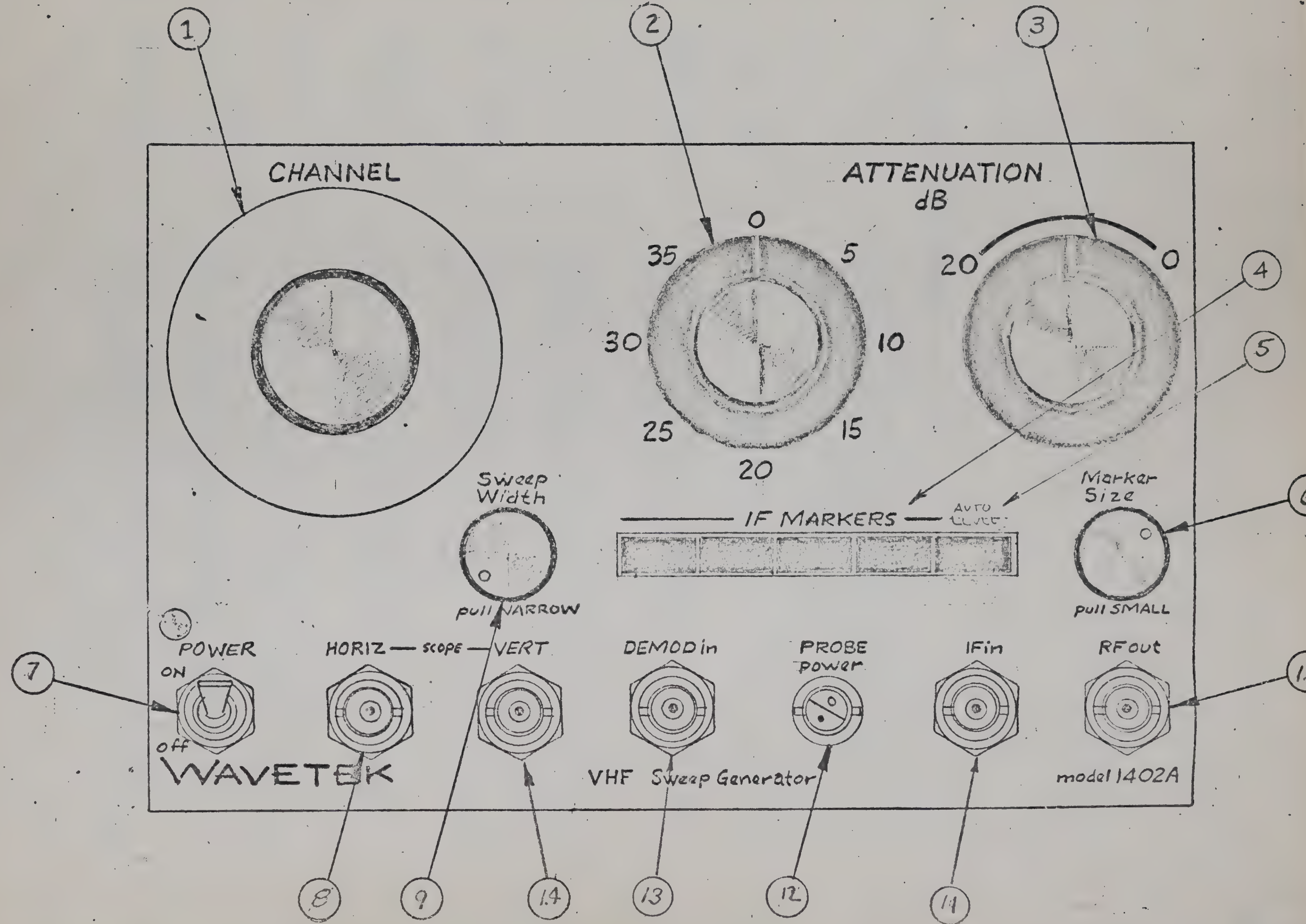
3.2 DESCRIPTION OF FRONT PANEL

(1) BAND - Switch desired band; 1 to 500 MHz, 450 to 950 MHz or 900 to 1400 MHz.

(2) FREQUENCY - A dual concentric center frequency tuning control. The Outer (coarse) knob calibrated in 10 MHz increments. The Inner (vernier) knob provides approximately $\pm$5MHz tuning range about the center frequency set by the coarse control.
NOTE: The coarse control will be on calibration when the calibration line of the vernier knob is aligned with the indicator line.

(3) OUTPUT (Step) - Provides calibrated adjustment of the RF output in 10dB increments, from +10dBm to -60dBm.

(4) OUTPUT (Vernier) - Provides a 20dB vernier adjustment of the RF output. calibrated in 1dB increments.



FRONT VIEW PANEL

3.2 DESCRIPTION OF FRONT PANEL

1	CHANNEL	36 position switch (14 position optional), programmed to the center frequency of IF and TV channels 2 to 13 (only, as an option) and CATV channels A to W. The switch also turns on the correct RF markers for each channel.
2	ATTENUATION (Step)	Provides calibrated adjustment of the RF output in 5dB increments from 0 to 35dB.
3	ATTENUATION (Vernier)	Provides a 20dB vernier adjustment of the RF output. When the AUTO LEVEL push button is depressed or when in remote operation, this control is not active.
4	IF MARKERS - (MHz)	Four push button switches control up to five IF markers, option D. The fourth switch controls two markers. (Marker frequency is engraved on pushbutton, the fifth marker frequency on the fifth pushbutton).
5	AUTO LEVEL	The fifth pushbutton switch, when depressed, controls the automatic level circuit, option C, and disconnects the front panel vernier attenuator.
6	MARKER SIZE pull SMALL	Control adjusts the amplitude of pulse markers added to the demodulated envelope at the scope VERT jack. When the knob is pulled out, the marker size will be reduced 90%.
7	POWER ON	Toggle switch applies A.C.power to the power supply. The light indicates that the instrument is operating.
8	SCOPE HORIZ.	BNC Jack provides a 16V peak-to-peak triangle waveform, synchronized with the sweep oscillator, to drive the oscilloscope horizontal amplifier.
9	SWEEP WIDTH	Control adjusts the display sweep width from less than 200 kHz to over MHz. When the knob is pulled

out the maximum sweep width is reduced to MHz.

10	RF out	BNC connector provides a connection for the RF output signal.
11	IF INPUT	BNC connector accepts an IF sweep sample to generate I.F. conversion local oscillator tracking markers, when option B is installed.
12	PROBE POWER	BNC twinax connector supplies +18 volts and -18 volts to power the active probe if it is required for the operation of option B or option C.
13	DEMOD in	BNC connector accepts the demodulated swept signal from the device under test, so that RF markers and scope frequency and level indicators, if option C is provided, may be added. This signal is also used to control the automatic RF level circuits of option C.
14	SCOPE VERT out	BNC connector provides the combined markers, and demodulated RF and scope indicators, option C. (when DEMOD in is connected) for connection to the oscilloscope Vertical (Y) axis input.

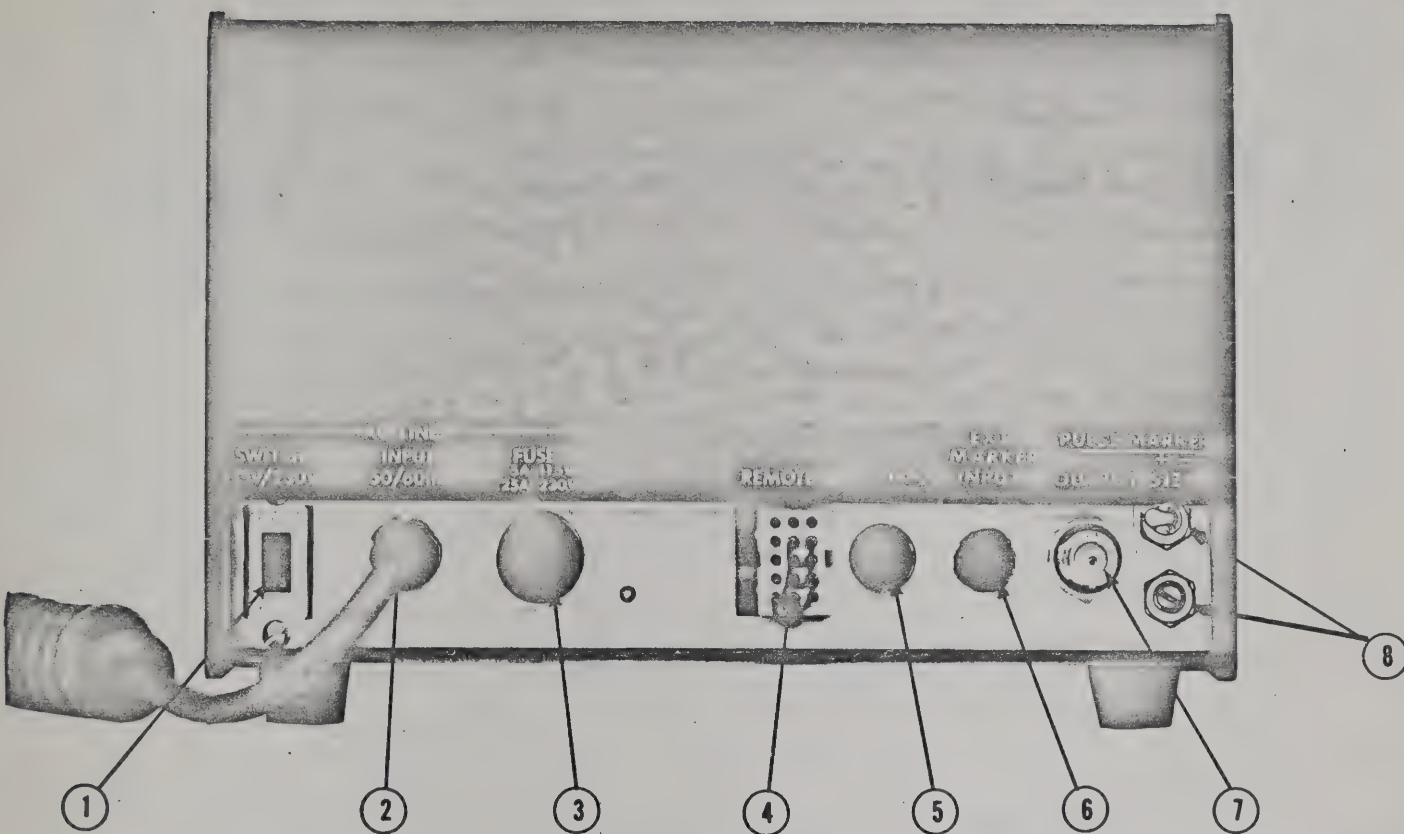


Figure 3-2. Rear Panel

3.3 DESCRIPTION OF REAR PANEL

1	SWITCH 115/230 VOLT	Selects 115 or 230 volt line voltage.
2	INPUT 50/60 Hz	3 prong AC plug provides connection to AC mains.
3	AC LINE FUSE	0.5A for 115 volt AC or 0.25A for 230 volt AC.
4	REMOTE Jack	Provides connection for programming of frequency and RF output level. (See paragraph 3-6 for detailed instructions). This jack is supplied with a mating "jumpered plug" which provides Front Panel control.
5	OPTION	Mounting hole for a BNC connector.
6	EXT MARKER INPUT	Mounting hole for a BNC connector.
7	PULSE MARKER OUTPUT	BNC connector provides positive or negative pulse markers, from IF tracking (option B), RF carrier and optional IF markers.
8	PULSE MARKER ± SIZE	Switch selects either negative or positive marker pulse. Control adjusts the amplitude of the pulses from 0 to over 30 volts.

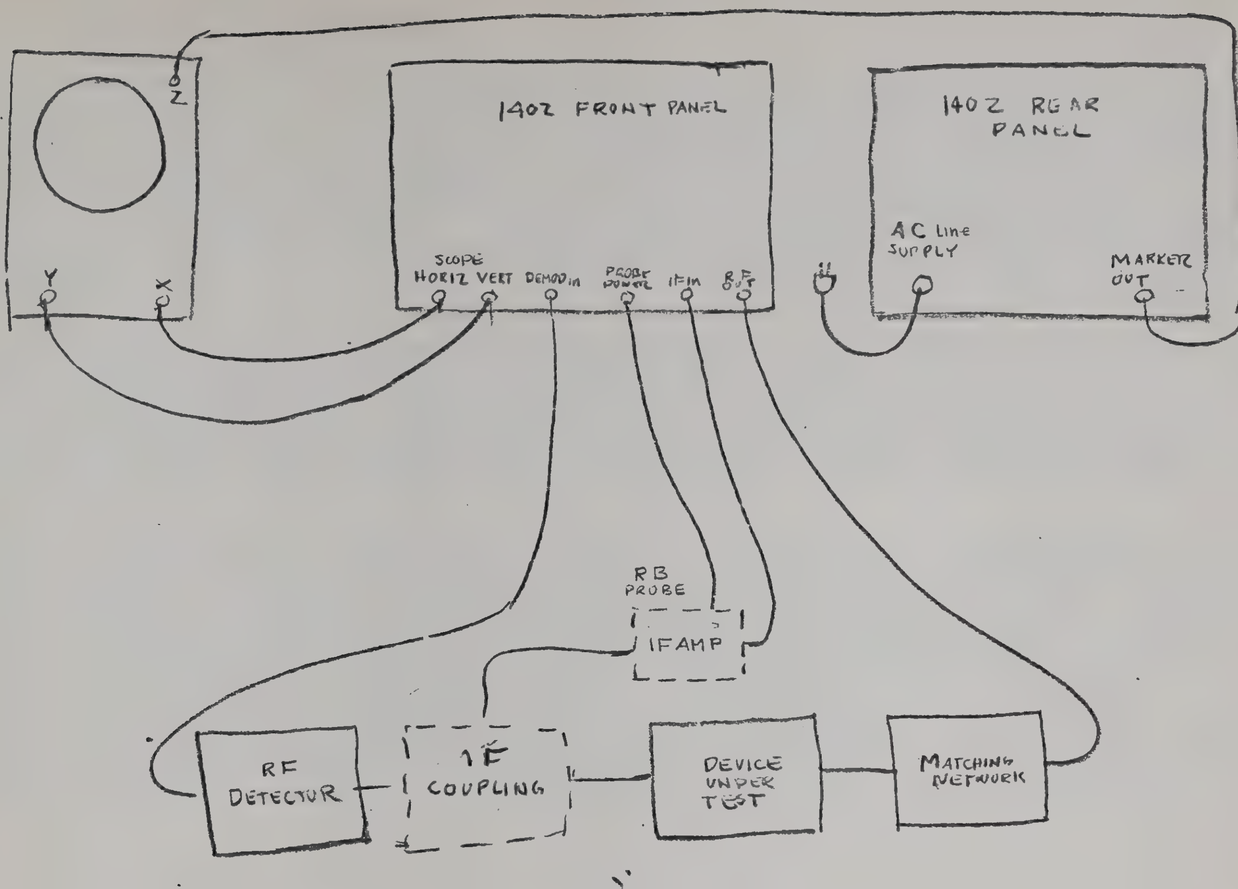


FIGURE 3-3 TYPICAL OPERATING SET UP.

3.4 TYPICAL OPERATING SET-UP

When initally setting up instrument, first check Rear Panel AC LINE VOLTAGE Selector Switch and Fuse to insure the instrument is set for operation with the available AC mains. When option C, automatic level and scope indicators is to be used, refer to paragraph 3-4.1 for adjustments of internal controls required for proper operation, before beginning Automatic Level operation. Be sure the AUTO LEVEL pushbutton is out before completing the set-up for manual operation.

Make connections between the sweep generator, the device under test and the oscilloscope as shown in figure 3-3. Since hum, RF leakage, and spurious signal pickup must be kept at a minimum, it is essential that good connections and ground be maintained throughout the entire set-up. Coaxial cables with BNC type connectors should be used wherever possible.

The RF output cable is especially critical. It must have a characteristic impedance identical with the sweep generators, typically 75 ohm. The cable should be kept as short as practical (under 3 feet). A matching network must be used between the 75 ohm RF output cable and the 300 ohm balanced input of the tuner to insure a constant amplitude input signal to the tuner. Either a resistive pad, figure 3-4, or a transformer matching network may be used. While the resistive pad is simple to construct, it provides more insertion loss than the balun-type transformer. The leads connecting the 300-ohm output of the pad to the tuner should be as short as possible (under 1 inch).

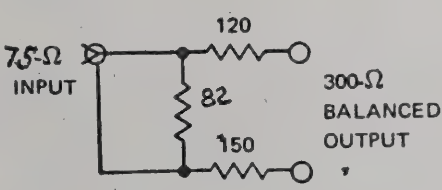


FIGURE 3-4

After the RF swept signal passes through the RF circuits of the device under test it must be detected (demodulated) before being connected to the marker adder or the scope vertical. In the case of the TV receiver alignment, the detector is already provided as a part of the receiver, while in aligning a tuner an external detector must be used. The detected signal is then connected to the DEMOD INPUT connector on the front panel.

When option B, IF Conversion Local Oscillator Tracking markers are used, an IF signal of 1 millivolt or more must be supplied to the front panel IF INPUT connector. This IF signal can be provided directly from the IF output signal of the device under test, or from the IF amplifier contained in the PROBE. If the IF amplifier PROBE is used, the required IF input from the device under test is 10 microvolts instead of 1 millivolt. This provides for a greater operating range of the marker and looser coupling to the device under test. If IF markers are desired at trapped frequencies, the IF pickup must occur before the frequencies are trapped out, see figure 3-5.

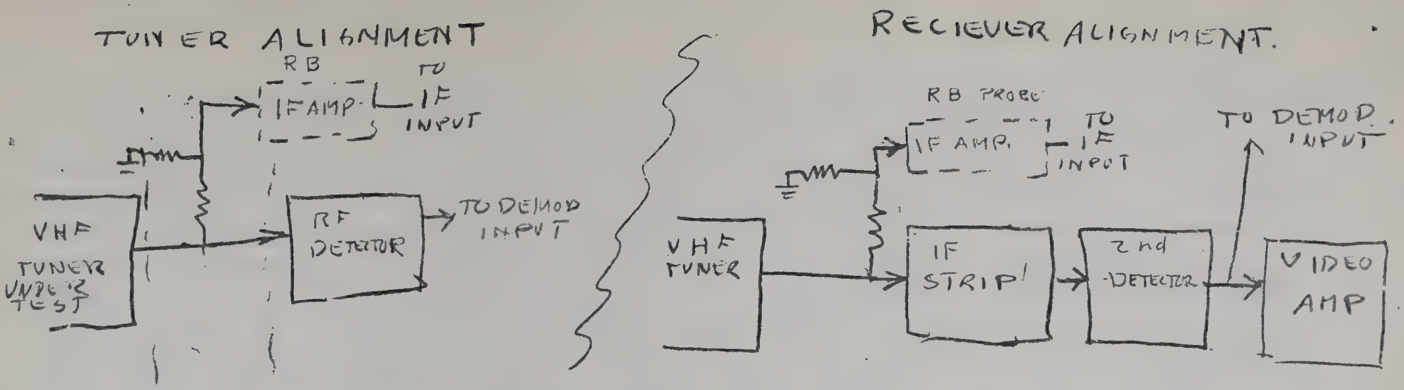


FIGURE 3-5 TYPICAL OPTION B
IF COUPLING

Switch Power On. The lamp should light, indicating an operating condition.

Note: This instrument requires no warm-up and is ready for immediate use.

After making necessary connections, set AUTO/MANUAL SWITCHES to the desired mode of operation. (A program can be used as explained in paragraph 3-6) Next, set frequency ATTENUATION, RF LEVEL, and SWEEP WIDTH as required. Turn on desired markers and adjust markers size for optimum display.

Note: The RF LEVEL control is inoperative in the automatic mode of operation.

3.4.1 INTERNAL SET-UP CONTROLS

The following internal controls are used only when option C, Automatic Level and Scope Indicators is used, and are related to the type of alignment set-up used the characteristics of the device under test and are adjusted at the operators discretion to provide the desired display. The top cover is removed by removing the single screw at the rear, and lifting the cover with a slight rearward movement. The internal controls are now visible. Each control is labeled and is described in reference to the module containing it as shown in figure 5-16. Care must be exercised when making these adjustments not to inadvertently turn one of the calibration controls.

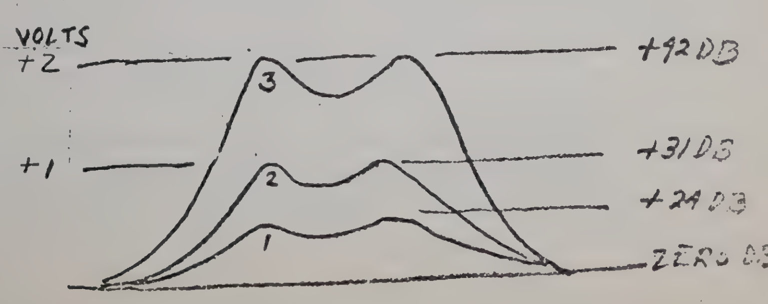
Option C, Automatic Level, Module M8E.

General Discussion

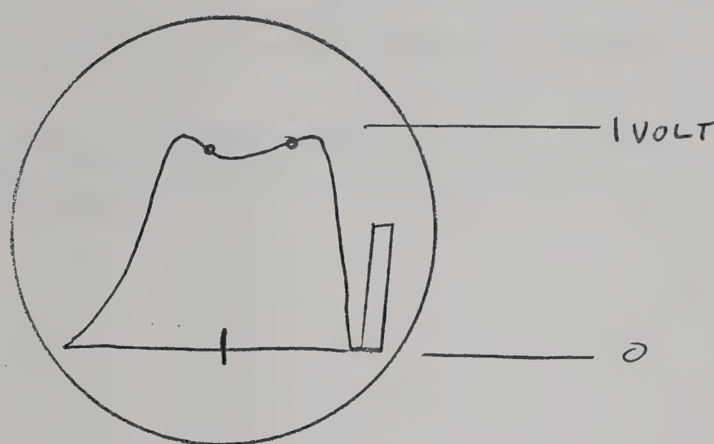
Two objectives of RF TUNER and other amplifier alignments are to maintain the circuit gain within the specified limits and to retain an acceptable pattern flatness, at the desired pass band. With the detected response amplified to a level which would provide a scope pattern of 1 volt peak, given typical limits as shown in table 3-1, the scope display could vary as shown.

TABLE 3-1

CHANNEL	TUNER GAIN DESIGN LIMITS	
	LOW GAIN	HI GAIN
2	+30 DB	+42 DB
13	+24 DB	+34 DB



By observing the pattern amplitude, we could determine that the tuner gain is within acceptable limits, but the pattern flatness would be difficult to estimate. With Option C, the pattern amplitude is maintained at a fixed level of 1 volt, by automatically controlling the RF input level. Flatness is now easy to determine. However, the tuner gain would not be known without knowing the RF input level. Option C provides level indicator pedestal on the base line of the tuner response pattern proportional to the RF output of the instrument and therefore inversely proportional to the gain of the tuner, i.e., when the indicator is at maximum amplitude (1 volt) the RF output level is 0dB, if there is even less tuner gain the pattern will become less than 1 volt while the indicator is saturated at 1 volt. As the tuner gain increases the pattern will return to 1 volt and not increase further, while the indicator will decrease in amplitude, on a linear voltage scale, over 20dB (.1 volt).



Internal set-up controls provide from 0 to 40dB of DC gain in order to interface with either low or high level detected Tuner output signals. Since the option requires a positive detected signal, a polarity reversing switch is also provided.

Set-Up Instructions

Connect as shown in figure 3-3 for normal manual operation. Remove the top cover of the instrument and adjust the controls on the M8E module as follows:

GAIN (VARIABLE) - counterclockwise, no gain
GAIN (X10) switch to right, no gain
POLARITY - switch for a positive pattern

Set the front panel controls the same as in manual operation with the AUTO LEVEL switch in "manual function". (not depressed) Disconnect the scope vertical connector and adjust the M8E - BAL control for DC balance.

Reduce scope vertical gain to 1 volt full scale and switch the M8E GAIN-X10 switch to the left (20dB gain). The tuner response pattern should be now visible. Rotate the "VARIABLE GAIN" control clockwise, if necessary, to obtain a 1 volt pattern. NOTE the amplitude of the RF level indicator pedestal.

Depress the front panel AUTO LEVEL pushbutton and readjust the VARIABLE GAIN control to restore the RF Level indicator pedestal to the same amplitude it had in manual operation. The instruments RF output level (0-20dB variable P.I.N. attenuator) is now operating automatically.

Option C - Frequency Indicator Pulse. Module M8E
The M8E module also provides a differentiated pulse, which will change position on the base line relative to the center frequency of the instrument. The Indicator RANGE and CENT controls are provided to allow it to cover the entire scope HORIZ scan for the frequency range being used. The frequency indicator adjustments are as follows:

Switch the Front Panel (or Remote) CHANNEL program switch to the highest frequency channel to be used.

Adjust M8E FREQ. IND. RANGE so the pulse is slightly in from the end of the display.

Switch to the lowest frequency channel and adjust FREQ IND CENT so the pulse position is the same at both ends. The scope horiz axis may now be calibrated in channels by ascending frequency.

3.5 SPECIAL OPERATING NOTES

3.5.1 Effects From Overloading

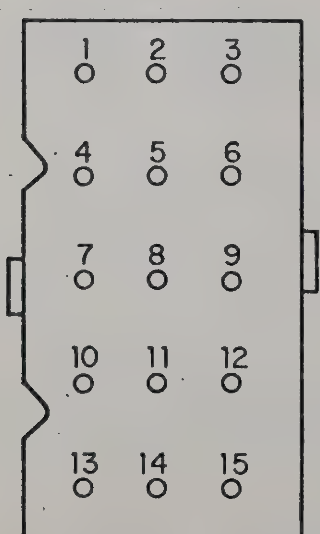
The use of excessive input signals to the device under test can cause overloading. To assure that this condition is not present, and that the response is a true representation of the device under test, turn the ATTENUATION AND LEVEL controls to minimum output amplitude. Gradually increase the output amplitude until a response is obtained. Further increase of the output amplitude should not change the configuration of the response envelope except in amplitude. If the response envelope does change, such as flattening at the top, decrease the output just far enough to restore the proper configuration.

3.5.2 Making Measurements at Low Levels

When making measurements at low levels, radiation and ground loops become problems. Using double shielded cables for carrying RF signals helps minimize the radiation problem. Ground loops causing hum pick-up can sometimes be eliminated by completing only one ground connection between each instrument. This applies particularly to the scope horizontal input. If the ground connection is made at the vertical input terminal, an additional ground at the horizontal input terminal will often result in hum pick-up.

3.6 PROGRAMMING

Connections for remote operation of OUTPUT AMPLITUDE, FREQUENCY and SWEEP WIDTH and for remote coupling of an automatic UHF with a companion basic VHF instrument is provided by a Rear Panel REMOTE programming connector. The programming jack and its pin functions are shown below.



Rear Panel
Remote Jack J 101

VOLTAGE AND SIGNAL SOURCES

Pin 1 - Ground
Pin 2 - +18 volts
Pin 3 - -18 volts
Pin 10 - Ramp for driving Sweep Width Control

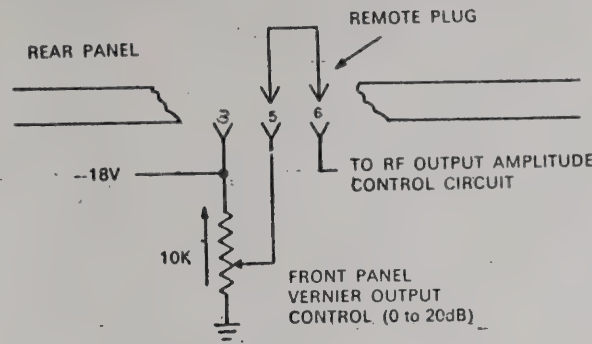
CONTROL INPUTS

Pin 6 - Attenuation Control
Pin 9 - Frequency Control (full band or in automatic frequency operation, controlled by companion instrument)
Pin 14 - Operate/Standby
Pin 15 - Capture - from companion instrument with automatic frequency control.

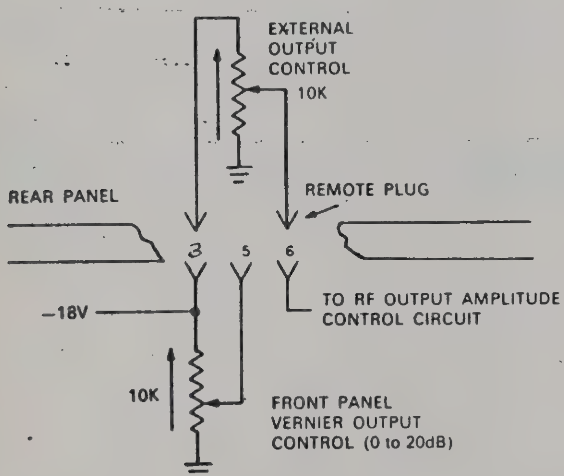
Internal Control - Pins 5, 8 and 11 are used to program internal operation of Output, Frequency and Sweep Width, pin 13 provides oscillator B- to be disconnected when in standby status when used with a companion sweep generator.

3.6.1 Output Amplitude Control

Normal internal control is provided by a jumper wire connected between pins 5 and 6 of the REMOTE plug as shown below.



To provide external control, remove jumper wire and connect an external OUTPUT Control as shown below. The RF OUTPUT is a linear function of the programming voltage as shown in figure 3-6.



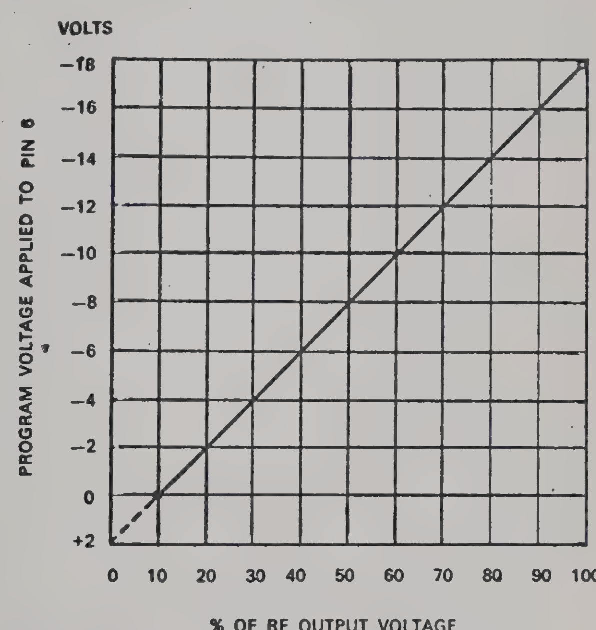
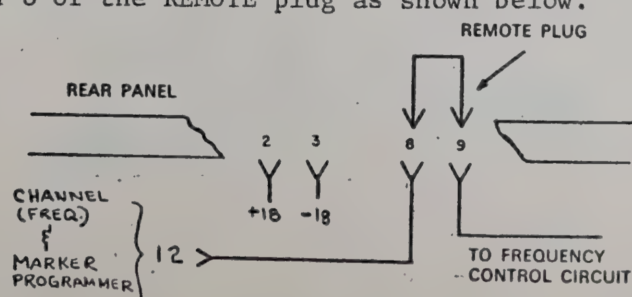


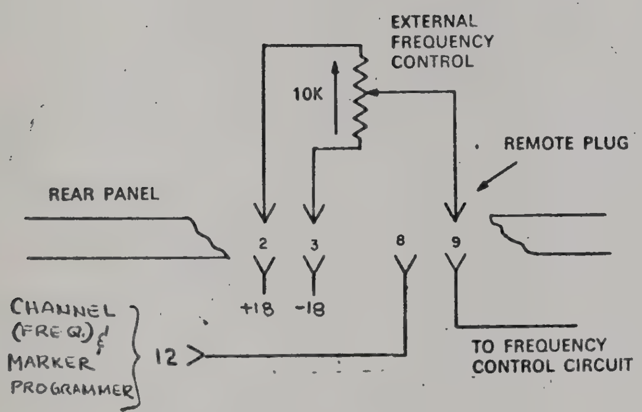
Figure 3-6. Program Voltage/RF Output

3.6.2 Frequency Control

Normal internal control of frequency is provided by a jumper wire connected between pins 9 and 8 of the REMOTE plug as shown below.

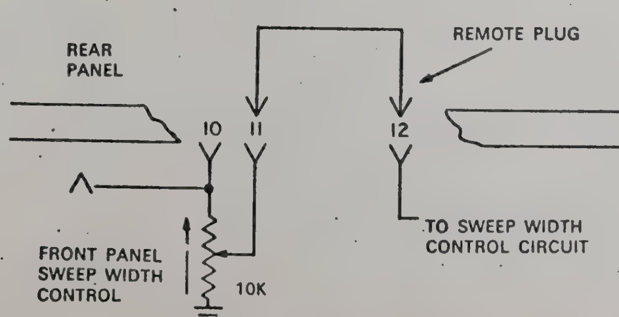


To provide external control, remove the jumper and connect pin 9 to an external frequency control as shown below.

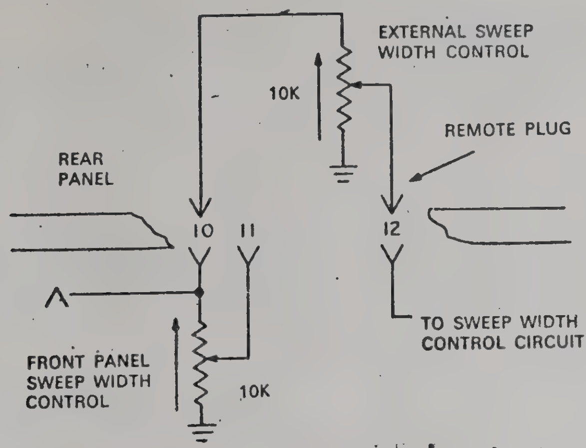


3.6.3 Sweep Width Control

Normal internal control of Sweep Width is provided by a jumper wire from pins 11 to 12 of the REMOTE plug as shown below. The NARROW sweep width circuit is not shown.



To provide external control, remove the jumpers and connect pin 12 to an external Sweep Width control as shown below.



SECTION 4
CIRCUIT DESCRIPTION

4.1 INTRODUCTION

This section first presents an overall block diagram analysis followed by a more detailed description of each module.

Before beginning the actual circuit description it would be well to consider the mechanical arrangement of the instrument. This will enable the following block diagram and circuit description to be associated with its physical position, thereby, providing a better understanding of the overall instrument. The mechanical arrangement can be seen by referring to Figure 5-14 in the Maintenance section. This TOP VIEW shows the Front Panel, plug-in module, and the rear chassis Power Supply sections.

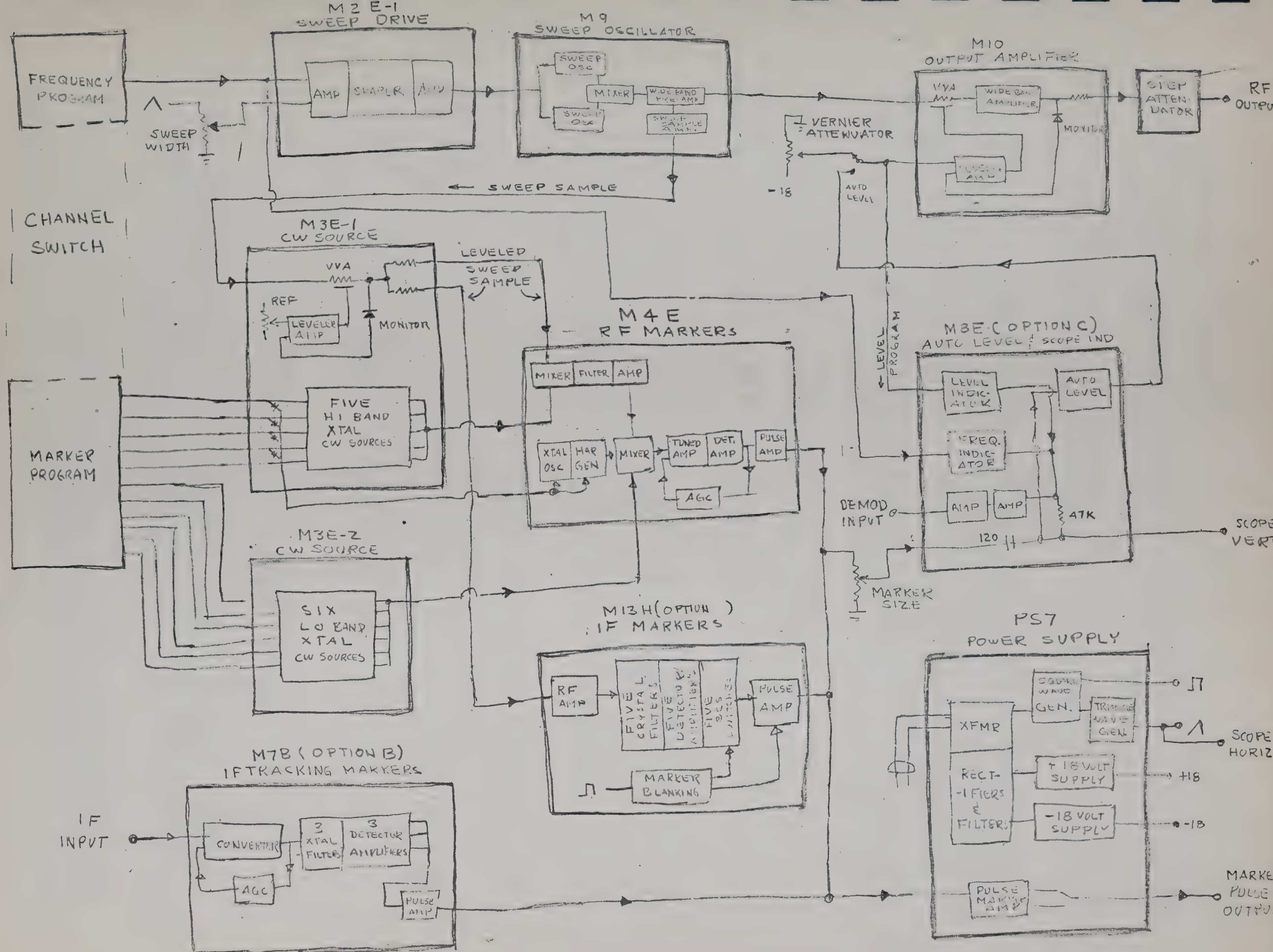


Figure 4-1 Simplified Block Diagram

4.2 SIMPLIFIED BLOCK DIAGRAM

The block diagram in figure 4-1 contains both block and module information. The blocks contained within each module are indicated by the shaded area.

The Power Supply provides two regulated voltage sources +18 and -18V Square Wave and Triangle wave generators for connection to the plug-in module. It also includes a Pulse marker amplifier circuit.

The two power supplies provide the voltage to the Front Panel CHANNEL switch while the triangle wave generator supplies the sweep ramp to the Front Panel SWEEP WIDTH control. Channel switch circuits set the tuning program voltage required for each channel center frequency. The output signals from the CHANNEL switch and SWEEP WIDTH control are then fed to the sweep drive circuits in the M2E-1 module where they are combined into a single signal which drives the Frequency Determining Varactor Diodes in the Sweep Oscillator module. Necessary level shifting, shaping and amplitude control is provided by the sweep drive circuit.

The square wave generator blanks the RF output and marker circuits off at retrace and controls the timing of other circuits in the instrument.

The RF sweep generator circuits are contained in two modules, an M9 Sweep Oscillator Module and an M10 Wide Band Amplifier Module.

The sweep signal is generated by hetrodyning two UHF sweep oscillators in a diode mixer. The resultant difference signal is then amplified in a wide band amplifier and connected to the M10 module. The M10 module contains a Voltage Variable Attenuator, the final output Wide Band amplifier, the Monitor Diode, and the Leveling Amplifier. The input signal from the M9 module is connected through the Voltage Variable Attenuator to the Wide Band Amplifier and then to the monitor point.

Leveling of the RF output is accomplished by the monitor diode which measures the RF voltage and compares it to a reference voltage supplied by the vernier output control. Any error between the two voltages is amplified in the leveler amplifier located in the M10 module. The error voltage is then connected to the Voltage Variable Attenuator at the input of the final wide band amplifier. This closed loop system point, which compensates for amplitude variations in the sweep oscillator, mixer, and amplifier circuit and also creates a zero impedance at the monitor point. In order to create a 75 ohm source impedance, a 75 ohm resistor is connected between the zero impedance point and the RF output system.

The output from the M10 module is then connected through the turret step attenuator to the front panel RF output connector.

The marker circuit is comprised of Crystal CW Source modules M3E-2 and M3E-1 RF Marker module M4E and Marker Adder module M8. The marker adding function of the M8 module is also contained in the Automatic Level and Scope Indicator module M8E. The CHANNEL program switch selects B+ voltage for the CW and harmonic sources required for each channel.

The M3E-2 module provides the crystal CW sources at the center frequencies of IF (channel 1) and channels 2 to 6. When the CHANNEL switch selects one of the six low channels, the proper source is turned on and routed to a diode mixer in the M4E module.

Crystal CW sources for channels 8 to 12 are within the M3E-1. Steering diodes at each source B+ supply line also activates a crystal controlled oscillator and harmonic generator in the M4E module, enabling the development of the RF markers of channels 7, 13 and A to W from the same crystal sources.

When the channel switch selects one of the 30 higher frequency channels the proper source is turned on and routed to an FET mixer in the M4E module.

In addition to providing CW sources the M3E-1 module also provides for the leveling of the sweep sample signal in the same manner as the main RF output signal was leveled. This provides a constant amplitude standardized sweep sample signal to the marker generating circuits in the M4E.

The M4E module accepts the VHF sweep sample which has been leveled and standardized in the M3E-1 module and a CW signal from either the M3E-1, in IF and channels 2 to 6 or the M3E-2 in channels 7 to 13 and A to W. The signals are hetrodyned in a mixer circuit and generate a zero beat note. This video signal is coupled to a dual gate MOS FET amplifier tuned to 2.25 MHz by LC tank circuits across one of its gates and in the drain load. The response is further amplified, demodulated, and sampled by an IC inverter which AGC's the tuned amplifier by regulating the bias on the second gate. The response is then amplified to saturation, producing sharp, negative going pulses at the RF carrier frequencies.

The CW sources used for channels 7 to 13 and A to S are hetrodyned with the sweep sample in a MOS FET mixer, fed through a 100 MHz low pass filter to a second, diode, mixer, which is also the primary mixer used for the six low channel markers. When in channel 7 to 13 or A to R, the beat signal is mixed with a signal from a 30 MHz crystal oscillator and harmonic generator, activated by diode switches in the M3E-1 module, which repeats the zero beat at 30 MHz intervals. In this way the CW source at the center frequency of channel 12, for example, serves as the source for channels E, 7, M, and R when sequenced by the channel program switch. When CATV channels S to W are sequenced, the 30 MHz crystal is P.I.N. diode switched with a 30.333 MHz crystal to produce a zero beat 91 MHz above the CW reference. Channel 12 CW source, therefore, also serves for channel W.

The optional IF marker circuit, in the M13H module, consists of a sweep sample amplifier, five independent plug in crystal filters, which generate the basic marker pulses in separate detector amplifier circuits, and a common pulse amplifier. The negative going output pulses are applied to the demodulated envelope through the M8 marker adder circuits, along with the standard RF markers, and through a detachable jumper, to the rear panel pulse marker circuits.

The M7B module provides pulse type Local Oscillator Tracking Markers generated from an IF sample derived from a TV tuner or receiver. The Conversion Circuits, which are AGC'd to prevent loss of markers from insufficient IF sample during tuner alignment, convert the IF sample to approximately 10 MHz. The converted signal generates RF markers in three crystal filters at converted equivalent frequencies. The Crystal Filter outputs are detected and amplified in identical Detector/Amplifier circuits and are applied to the common Marker Pulse circuit which generates sharp negative going marker pulses.

The Marker Pulse circuit output is routed to the Marker Pulse Amplifier circuit in the PS7, Power Supply, which provides either positive or negative going Pulse Markers at the rear panel. The Marker Pulses are also fed, through a detachable jumper to the marker adder in the M8 module where they may be added to the detected response pattern from the DEMOD INPUT jack.

The Option C Automatic Level and oscilloscope level and frequency indicator circuits are contained in an M8E module. The module also contains high impedance adjustable gain scope preamplifier circuits, and pattern inverters to permit automatic level (Attenuation) with either high or low level tuners without using external DC amplifier probes. The level indicator pedestal, the frequency indicator pulse and the marker signals from the Front Panel MARKER SIZE control are combined with the demodulated input signal for connection with the scope vertical or "Y" axis input.

When option C is not used, module M8 is used in place of module M8E. In this module the DEMOD INPUT is connected directly to the 47k ohm resistor. The marker signals are coupled through the 120pF capacitor to the resistor and to the SCOPE VERT output connector. No other circuits are provided in this module.

THE FOLLOWING CIRCUIT DESCRIPTIONS ARE REFERENCED TO THE SCHEMATICS APPEARING IN SECTION 6.

4.3 POWER SUPPLY (PS7)

The PS7 power supply provides two regulated voltages, a square wave generator, a Triangle Wave Generator and a Marker Pulse Amplifier.

AC POWER & RECTIFIER CIRCUITS

A dual-primary transformer allows operation at a line voltage of 115 or 230 volts. AC power is supplied through a 3 wire receptacle from the Front Panel ON/OFF switch. The transformer is located away from the sweep drive module to reduce magnetically coupled line ripple. Unregulated plus and minus voltages are supplied by two full wave rectifier circuits and filtered by C1 and C7. A 12 pin plug, mounted to the printed circuit board, provides access to three unregulated voltages the regulated +18 and -18 supplies, Square wave and Triangle wave sources and an input to the Pulse Marker Amplifier. R45 is a series voltage dropping resistor for the Power On indicator DS101.

+18 VOLT SERIES REGULATOR

Regulation is provided by IC1 which contains its own internal reference supply. Resistor R9 provides an adjustment to +18.00 volts. An external pass transistors, Q2, boosts the current capability, and transistor Q1 improves the current limiting characteristics of IC1 by providing amplification before limiting. The +18 volt supply is protected against reverse voltage by diode CR7.

-18 VOLT SERIES SHUNT REGULATOR

The voltage reference for this supply is obtained from the +18 volt supply through resistor R20. Resistor R19 provides feedback, applied to IC2, which provides high gain, forcing transistor Q5 to maintain a shunt regulated voltage across resistor R13. Transistors Q3, and Q4 provide the series pass element and are connected as a compound emitter follower so that the voltage across resistor R13 is not loaded heavily. Short circuit protection of transistor Q5 is provided by diode CR8. Current limiting is provided by transistor Q5, when transistor Q6 conducts sufficiently to forward bias diodes CR9 and CR10. Reverse voltage protection is provided by diode CR12.

SQUARE WAVE GENERATOR

The 24 volts ac from power transformer T1 is squared by the comparator IC3A. Diodes CR13 and CR14 provide protection to the inverting input by limiting the voltage range to one volt. The square wave output, provides the triangle generator input and is also applied to the base of the Darlington emitter follower Q7. CR15 limits the negative output to one volt. A positive 15 volt, negative 1 volt square wave is routed to pin 10 where it is provided to blank the RF output off during retrace and to control the timing of other circuits in the instrument.

TRIANGLE WAVE GENERATOR

The symmetrical square wave output of IC3A is adjusted by R26 and is ac coupled to the integrator IC3B to restore symmetery about zero. Diodes CR16 and CR7 protect the inverting input by limiting the voltage range to one volt.

Capacitor C13 and Resistors R29 and R30, in the feedback network, provide the integrator configuration. This signal applied to pin 8, provides the sweep ramp, the scope horizontal drive, and controls the timing of other circuits in the instruments.

MARKER AMPLIFIER

Negative going marker pulses from M7 and from M4 and M13 modules in the instrument are routed through pin 7 and AC coupled to the base of the PNP inverter Q12. The collector signal is DC coupled through the divider network R41 and R42 to the base of the NPN inverter Q13.

Positive going pulses are selected from the collector of Q12, or negative going pulses from the collector of Q13 by marker polarity switch S2, and coupled to the marker size control R44. The pulse is then applied to the marker output jack, J5.

4.4 CHANNEL PROGRAM SWITCH

The CHANNEL Program Switch provides the analog voltages required to tune the sweep oscillator to the center frequency of each of the channels indicated on the dial. The switch also turns on the crystal controlled CW sources required to provide the proper RF carrier markers at the selected channel.

FREQUENCY PROGRAM

The IF (channel 1) program is a negative voltage set by the precision voltage divider network between -18 volts and ground, consisting of resistors R1, R2 and R4. Potentiometer R3, in parallel with R2, provides precise adjustment of this voltage.

The low band TV channel programs are set by the precision resistor divider network R9 to R12. The channel 2 voltage is adjusted by potentiometer R7, and the channel 6 voltage adjusted by R14. The operational amplifier voltage followers, IC1A in series with the channel 2 control, and IC1B in series with the channel 6 control, prevent loading of the adjustment potentiometer by the frequency program output.

The high band VHF TV channel and the CATV channel program voltages are established by a similar voltage divider network between -18 and +18 volts with voltage adjustments at approximately five channel intervals in ascending frequency from less than -3 volts for channel A, to more than +3 volts for channel W. When the optional CHANNEL switch, programmed only to U.S. standard VHF TV channels is used, the high band voltage divider network adjustment controls and operational amplifier voltage followers are at channel 7 and at channel 13.

The active contacts of the channel selector switch S1, section A, are wired so as to group the TV IF and channels 2 to 13 together, followed by CATV channels A to W as displayed on the CHANNEL knob dial. The frequency program voltage, as selected by the common of section A, is routed through plug P102, pin 12 and is applied to pin 5 of the M2E-1 sweep drive module.

MARKER PROGRAM

Channel Selector Switch S1 section B provides B+ voltage to the crystal controlled RF CW sources in the M3E and M4E modules required to provide RF channel markers at each channel selected, +18 volts is supplied from pin 14 of plug P102 to the common contact of this section for this purpose.

When TV IF or channels 2 to 6 are selected, B+ is applied to the active contacts connected pins 1 to 6, activating crystal CW sources at the Center Frequencies of channels 1 (IF) to 6. Selecting TV channels 7 to 13, as when the optional US standard VHF TV CHANNEL switch is used, applies B+ sequentially through P102 pins 7, 8, 9, 10, and 11 to pins 12, 8, 9, 10 and 11 of the M3E-1 mdoule, thus

activating center frequency sources of channels 12, 8, 9, 10 and 11. As each M3E-1 source is activated, steering diodes activate a 30 MHz harmonic generator in the M4E marker module. By means of the 30 MHz offset, the center frequency CW source for channel 12 serves for channel 7. By means of a +30 MHz offset, the center frequency of channel 8 also serves for channel 13.

When the standard 36 position CHANNEL program switch is provided, the same five center frequency CW sources are used. Channels A to R use the 30 MHz harmonic generator employed for deriving channel 7 and channel 13 markers as described above. In this manner, for example, the channel 8 Center Frequency source is offset -60 MHz to serve also for channel A, is offset -30 MHz for channel F, and +60 MHz for channel N.

When channels S to W are selected, the same five center frequency CW sources are also used. However, the 30 MHz harmonic generator in the M4E module is PIN diode siwtched to a 30.333 MHz harmonic generator through diodes CR6 to CR10. Diode CR1 to CR5 prevent this crystal switching when the lower frequency channels are used. In this way, by means of a +91 MHz offset, the Center Frequency CW source of channel 8 also serves for channel S.

4.5 SWEEP DRIVE (MODULE M2E-1)

The M2E-1 module provides the drive voltage to the varactor diodes in the sweep oscillator module as determined by the programming voltage applied to PIN 5, and 7 by the CHANNEL and SWEEP WIDTH controls. R3, 4, and 41 divide the frequency program in half, so that it is equal to the sweep width program. The programs are summed to a standard voltage level in the input amplifier IC1A and then fed to the shaping circuit. The shaping diodes (CR1 to CR5) conduct at levels determined by a variable resistor network driven by a constant current source Q1. As each diode conducts, an additional current is fed into the summing junction of the output amplifier IC1B. The output amplitude is set by R31, the sweep width limit control.

4.6 SWEEP OSCILLATOR, (MODULE M9H)

The RF sweep signal for band 1 is developed by the hetrodyne method which utilizes two UHF sweep oscillators, a diode mixer, and a wide band RF amplifier.

Sweep oscillator, transistor Q2, sweeps from approximately 1.4 to 1.65 GHz. The average frequency is adjusted by resistor R2 which controls the average bias on the varactor diodes, CR1, CR2 and CR3. The sweep drive voltage from pin 9 of the module is connected to the opposite side of these diodes causing the frequency to vary above and below this average frequency in a low-to-high frequency direction.

Transistors Q8, Q9, and Q10 provide a -15 volt supply to operate the sweep oscillators. This improves stability and provides isolation between the oscillators and the -18 volt supply.

Sweep oscillator transistor Q5 is similar to the Q2 circuit, however, the varactor diodes have been reversed and the polarity of the bias voltage supplied by R12, COARSE adjustment, and R13, CENT FINE adjustment, has been changed. These changes cause the oscillator frequency to vary from a high-to-low frequency. The approximate output frequency is 1.4 and 1.15 GHz. This out of phase sweep technique has several advantages. First, larger sweep widths are obtainable and second, the nonlinearity (FREQ versus TIME) of one oscillator is cancelled by the nonlinearity of the second oscillator. Resistor R9, which is a linearity adjustment, optimizes this cancelling process by controlling the sweep drive ratio between the oscillators.

The two sweep signals are combined in a single balance diode mixer comprised of inductors L4 and L5 and diodes CR8 and CR9. The resultant, difference frequency of 0 to 500 MHz, is then amplified in the wide band amplifier consisting of transistor stages Q11, Q12 and Q13.

Transistors stages Q6 and Q7 supply the blanking voltage to the wide band amplifier and cause it to be shut off during the sweep retrace time. The output from the wide band amplifier is connected to J. which in turn is connected to the output wide band amplifier located in module M10. A second output is also obtained from this amplifier and is coupled, via resistor R45, to a similar wide band amplifier consisting of transistor stages Q14, Q15, and Q16. The output from this amplifier is connected to J2 which in turn is connected to the marker generating circuits.

4.7 OUTPUT AMPLIFIER (MODULE M10 [ ]A

The M10 module contains an Electronic Attenuator, a Wide Band Amplifier, an Output Monitor and Leveler. The suffix Letter "A" denotes a source Z of 75Ω

ELECTRONIC ATTENUATOR
Ahead of the first RF amplifier is an electronic attenuator consisting of PIN diodes, CR1, CR2 and CR3 which provides variable RF conductance proportional to the positive current supplied through switching transistor Q7.

WIDE BAND AMPLIFIER
This amplifier provides 2 stages of RF amplification to increase the RF input level present at transistor Q1 by about 40dB, with a reduced frequency response for frequencies near 0.5 MHz or lower and above 400 MHz. Each amplifier Q1 and Q4 is followed by two emitter followers Q2, Q3 and Q5, Q6.

MONITOR AND LEVELER
The output of the wide band amplifier is connected to the monitor diode CR8, which provides a negative DC voltage related to the RF output level present in the output system. This negative voltage is connected to one input of the leveler amplifier consisting of Q8, Q9, And Q10.

The second input to operational amplifier is provided by the output level control. Any error between the two inputs is amplified and used to control the electronic attenuator. This closed loop system maintains a zero impedance, constant amplitude signal at the monitor point and allows an adjustment of the signal over a 20dB range.

A positively increasing output voltage from the leveler amplifier will increase the RF output level. RF blanking is effected by a positive input voltage (pin 4) to switching transistor Q7 which causes the leveler output (pin 6) to go negative during sweep retrace time shutting off the electronic attenuator.

The output impedance is provided by the resistor connected between the monitor and the RF out connector.

4.8 CRYSTAL SOURCE (MODULE M3E-1)

Crystal source module M3E-1 contains the five crystal controlled oscillator and frequencies multiplier circuits used in providing markers for the high band VHF TV channels, and the CATV channels. It also contains a sweep sample leveler.

The crystal oscillators, transistors Q1, are a tuned Colpitts type with the crystal operating at its third overtone frequency, in a series resonant mode. The tuning suppresses the crystal fundamental and higher order resonant frequencies.

The output signals of the crystal oscillators are capacitively coupled to the base of the frequency multiplier transistors Q2, with parallel resonant LC tanks in the collector load tuned to the fourth harmonic of the crystal oscillator output. Sympathetic, echo, tanks tuned to the same harmonic frequency, transformer couple the center frequency CW signal through capacitors C12 to the CW output jack J1.

The oscillators and frequency multipliers are switched on one at a time as sequenced by B+ voltage applied to feedthru C6, A to E. The module pin number is the same as the TV channel center frequency of the CW source it controls. Diodes CR1 apply this B+ voltage to pin 7 when any CW source in the module is switched on. This voltage at pin 7 is the B+ source for a crystal controlled oscillator and a harmonic generator in the M4E-1 module, used to hetrodyne to the center frequencies of the high band TV channels and CATV channels not provided by this module. PIN diodes CR2, in series with the output coupling loop, provide an RF block to prevent the CW source output from ringing with the output tanks of an inactive source circuit.

A low level sweep sample signal supplied from the sweep oscillator module M9H is connected to jack J2. This signal is then leveled in the same manner as the main RF output signal. The voltage from the monitor, diode CR4, and the reference voltage from R19 is fed to the leveling amplifier consisting of transistor stages Q4 and Q5. Q3 provides blanking of the leveling amplifier. Any error between the two input signals is amplified and fed to the PIN diode attenuator CR3. The operation of this circuit produces a constant amplitude signal at the monitor point. 47 ohm resistors connected between J3 and the monitor point, and between J4 and the monitor point establishes each sweep sample source impedance at approximately 50 ohms. One sweep sample output signal is routed to the M4E module. The other signal is provided for the IF marker module M13H.

4.9 CRYSTAL SOURCE (MODULE M3E-2)

Crystal source module M3E-2 contains the six crystal controlled CW sources used to provide markers for the low band VHF TV channels, and IF (Channel 1)

The crystal oscillators, transistors Q1, are a tuned Colpitts type with the crystal operating at its third overtone frequency in a series resonant mode. The tuning supresses the crystal fundamental and higher order resonant frequencies. (The roman numeral reference symbol suffix on the parts list is the same as the channel number shown for each source on the schematic.)

The crystal oscillator output signal of channel 1 (IF) is coupled directly to the CW OUTPUT jack, J1. The crystal oscillator signals for channels 2 to 6 are capacitively coupled to the emitter of the common base configured transistor Q2. C10 and L4 in the collector load are tuned to the parallel resonance of the second harmonic of the crystal oscillator output. C11 couples the doubled oscillator output to the CW OUTPUT jack, where it is then fed to the second mixer of the M4E, RF marker, module. The CW sources are switched on one at a time as sequenced by the program switch by applying B+ voltage to C6. The module pin number is the same as the TV channel center frequency of the crystal source it controls.

4.10 RF CARRIER MARKERS (MODULE M4E)

The M4E Marker Module contains an FET mixer, a low pass filter, an RF amplifier, a Diode Mixer, a crystal oscillator, with two series crystals and a PIN diode switch, a 2.25 MHz tuned amplifier circuit, a pulse detector/amplifier, an AGC circuit, and an output pulse amplifier.

MOS FET mixer Q1 accepts a leveled and standardized sweep sample from the M3E-1 module at connector J1, and when either the CATV or the high band VHF TV channels are selected, also accepts a center frequency CW signal from the M3E-1 module at J2. The LC filter, consisting of capacitors C4 to C8, and chokes L1, L2 and L3 in the drain load, attenuate the fundamental and the product signals, and pass the difference signals. In IF and the low band VHF TV channels 2 to 6, the circuits serve as a sweep sample amplifier.

The filtered output of Q1 is fed to the base of RF amplifier Q2, and then to the diode mixer CR1. In the low band channels, a center frequency CW signal is also fed to the diode mixer from the M3E-2 module. The resultant hetrodyne signal is coupled through L7, and C17 to one gate of the tuned amplifier Q5, Q8 couples a sample of this signal to pin 1 for use by the M6P marker modules when additional RF markers are required.

When programmed to the high band VHF TV and the CATV channels, a crystal oscillator, Q4, and harmonic generator Q3 are activated by B+ applied to pin 9. The crystal oscillator is a tuned Colpitts type with the crystal operating at its third overtone frequency in a series resonant mode, and tuned to suppress the crystal fundamental and higher order resonant frequencies. Crystal X1 is used in channels 7 to 3 and A to R. When channels S to W are selected, +18 applied to pin 8 reverses the current through PIN diodes CR2 and CR3. Diode CR2 conducts and becomes an RF short circuit around X1. CR3 becomes an 0 pin circuit at RF thereby inserting crystal X2 into the circuit. The 30 MHz crystal oscillator now becomes a 30.33 MHz oscillator. The 30 or 30.33 MHz signal is fed to the harmonic generator Q3, and then to the diode mixer circuit, where it is used to offset the hetrodyne response by 30 or 60 MHz in channels 7, 13, and A to R, or by 91 MHz in channels S to W.

The MOS FET amplifier Q5 is tuned to 2.25 MHz by parallel resonant tank L6 and C16 at one gate and by L12 and C30 in the drain load. The output response is demodulated and amplified by Q6 and Q7, , and amplified to saturation by Q8. Operational amplifier IC1 samples the pulse response and automatically adjusts the gain of the tuned amplifier, Q5, by regulating the bias on the second gate. This AGC keeps the pulse markers at the same level of saturation throughout the range of the instrument.

Transistor stages Q9 and Q10, and Q11 and Q12 further develop the signal to fast rising negative going pulses at pin 7. Pin 12 provides the B- voltage to be used by additional RF marker modules M6P, and also accepts the marker pulses from the M6P module when it is provided.

4.10.1 ADDITIONAL RF MARKERS (MODULE M6P)

When additional RF markers are required at each channel, the instrument is wired to accept an M6 size marker module M6P containing a MOS FET amplifier tuned to the difference between the required marker frequency and the channel center frequency and the same type of detector, AGC, and pulse amplifier circuits used in the M4E module.

The hetrodyne video from the diode mixer in the M4E module is fed through pin 1 to pin 2 of the M6P, where it is applied to a gate of Q1.

The MOS FET amplifier Q1 is tuned by parallel resonant tank L1 and C3 at one gate and by L2 and C3 in the drain load. The output response is demodulated and amplified by Q2 and Q3, , and amplified to saturation by Q4. Operational amplifier IC1 samples the pulse response and automatically adjusts the gain of the tuned amplifier, Q1, by regulating the bias on the second gate. This AGC keeps the pulse markers at the same level of saturation throughout the range of the instrument.

Transistor stages Q5 and Q6, and Q7 further develop the signal to fast rising pulses applied to pin 3 where it is fed to pin 12 of the M4E module, and to the common base configured output stage of this module. The B- voltage required to operate the M6P module is provided through pin 12 of the M4E to pin 3 of the M6P

4.11 IF MARKERS (Module M13H)

This module contains a sweep sample amplifier, five crystal filter circuits, pulse detectors, pulse amplifiers and SCS switches and a common output pulse amplifier. A blanking circuit turns the markers off at retrace.

The sweep sample amplifier Q9, is a common emitter broadband amplifier. The collector load of the amplifier, RF transformer T1, is coupled to match the input through series impedance of the crystal filter circuit.

The crystal filters are very high "Q" resonant circuits developing sharp bursts of RF energy at their series resonant frequencies. These bursts of RF are detected by CR1, and applied to the base of the first pulse amplifier Q1. Pulse amplifier Q1 and Q2 convert the small output from the crystal filters to DC voltage pulses when B+ is supplied to their collectors from the proper IF MARKER pushbutton switch. The amplified pulses are then applied to the anode gate of the SCS, Q3.

The marker blanking circuit Q6, Q7 and Q8 turn Q3 off in retrace time by removing B+ from its anode. The pulse is further amplified by Q4 and Q5 which are common to all five filter channels. A blanking gate from Q6 biases Q4 off in RF off time. The sharp negative going pulses are then routed to the marker adder circuits in the M8 module, and also through a detechable jumper to the pulse marker amplifier in the PS7 POWER SUPPLY.

4.11.1 THREE SINGLE FREQUENCY RF MARKERS (MODULE M13S)

In certain special purpose instruments, the socket provided for the optional IF markers, module M13H, is occupied by an M13S module which provides three single frequency birdy markers. The markers are on all of the time as they are not controlled by the Front Panel IF MARKER switches.

The module contains three crystal oscillators, tuned mixers, and marker amplifiers, a common operational amplifier inverter, a low pass filter, a second op. amp. inverter and a noise clipper.

The crystal oscillators, Q1, A, B, and C, operate at frequencies between 17 and 55 MHz. Each is a tuned Colpitts oscillator with the crystal operating at its third overtone frequency in a series resonant mode. The tuning supresses the crystal fundamental and higher order resonant frequencies. The crystal and marker frequencies are the same for frequencies below 55 MHz. The markers above 55 MHz use harmonic generating techniques.

The output from each crystal oscillator or harmonic generator is combined with the sweep sample in the mixer stages, CR2, A, B, and C, which include tuned circuits that select the desired crystal or crystal harmonic frequencies and the sweep sample frequency. The fundamental and product signals are filtered from each mixer output, leaving the difference signals which are applied to the marker amplifier stages.

The marker amplifier stages transistors Q2, A, B, and C, are single stage amplifiers having a frequency response of several kHz to approximately 500 kHz. The output of each marker amplifier is connected through its SIZE control R9, A, B, or C, respectively, to the inverting input of the operational amplifier IC1A. In modified instruments, similar video responses from other M6 type modules may be applied to this junction through a feedthru at pin 1.

The integrated circuit operational amplifier, the "A" section of IC1, combines and amplifies the individual marker inputs. The amplified signal is coupled across L6, which provides further filtering to the "B" section of the dual operational amplifier IC1. The output of this second inverting amplifier is fed to the complementary output stage or noise clipper, Q3 and Q4, which is biased so that input signals of less than 0.5 volts are not amplified. This eliminates most spurious markers and noise from the output.

4.12 IF TRACKING MARKERS (MODULE M7B)

This module contains a conversion circuit, consisting of a bandpass filter, RF amplifier, local oscillator, mixer, 10 to 20 MHz IF amplifier and output Transformer. It also contains an automatic Gain control (AGC circuit), three crystal filters and their associated Detector Amplifier stages and a common Marker Pulse amplifier.

CONVERSION CIRCUIT

The bandpass filter consists of the inductive/capacitive tuned networks at the inputs to MOS FET Q1. The filter passes the frequency band from 30 MHz to 50 MHz. The Q1 stage is an RF amplifier that couples the IF frequencies to one input of mixer Q3. The other MOS FET input receives the 55.75 MHz signal from crystal-controlled Colpitts oscillator Q2. The AGC voltage is also applied to the mixer at this point. The 55.75 MHz local oscillator heterodynes with the output of Q1 to provide output frequencies from 0 Hz to approximately 20 MHz with 10 MHz now corresponding to 45.75 MHz and 14.5 MHz to 41.25 MHz.

The output of the mixer and the following MOS FET amplifier, Q4, drives Pi-networks that are stagger-tuned, in conjunction with the secondary of T1, to provide the required flat response. Frequencies below 10 MHz are attenuated by choke L8, and series traps C26/L10 and C29/L11. Frequencies above the desired band are attenuated by the low pass filtering of the Pi-networks.

AGC CIRCUIT

A sample of the signal level is coupled from the collector of Q19 to the AGC circuit consisting of monitor diode CR4 and the operational amplifier inverter Q15 and Q16.

Crystal Filters and Detector Amplifier Circuits

The secondary of T1 is center tapped to provide 180 degree phase displaced signals to the three crystal filters. When US standard TV IF is used, one crystal, for example, may provides a 14.5 MHz output for the 41.25 MHz marker and another crystal may provides a 10 MHz output for the 45.75 MHz marker. In each case, the crystal in the filter is selected for a frequency that is the difference between the M7B local oscillator frequency and the desired marker (for U.S. standard sound and video, this is: 55.75 - 41.25 = 14.5 and 55.75 - 10 = 45.75).

The crystal filter outputs are nulled for zero output, except at resonance, by variable capacitors C30, C32 and C34. These crystal filters provide sharp burst of RF energy at their series resonant frequencies, detected by CR3 and amplified by Q7. Emitter follower Q8 is a low impedance input to differentiator CR4 which provides a sharp pulse input to amplifier stage Q9. The outputs from the collectors of the three Q9 stages are coupled to the common marker pulse amplifier.

Marker Pulse Amplifier

The combined marker pulses are amplified to saturation by complimentary amplifier Q10 and Q11 generating sharp negative going marker pulses, which, through pin 6, are routed to the PS7 Power Supply & Marker Pulse Amplifier circuits described in paragraph 4-3, and also to the marker adder module M8, or Automatic Level and Scope Indicator module M8C when option C is provided.

4.13 AUTOMATIC LEVEL & SCOPE INDICATORS (MODULE M8E)

The M8E module provides adjustable 40dB gain to the demodulated input from the front panel, selectable polarity inverting circuits and a RC network for adding markers to this demodulated signal. It primarily provides an automatic RF level (attenuation) dc voltage to the M9 Sweep Oscillator leveler reference input. automatically adjusting the RF output level to a value that will maintain a constant amplitude demodulated tuner response. The module also provides oscilloscope indications of the RF level program by means of a vertical pedestal or pulse on the retrace base line, whose amplitude varies directly with the RF level program amplitude, and of the frequency (tuning) program by means of a narrow differentiated pulse that moves across the base line in step with the tuning voltage program in ascending frequency from left to right.

DEMODULATED INPUT AMPLIFIER, INVERTER & MARKER ADDER

The demodulated response of the tuner under test is fed from the DEMOD INPUT jack to pin 8, and is AC coupled to FET transistors Q1 and Q2, and the A section of operational amplifier IC1, which are connected as a potentiometric amplifier. Diodes CR1 and the divider network R8 to 11 provide input gate protection. VAR GAIN potentiometer in the feedback network adjusts the amplifier gain. The output signal is applied to the low gain (X1) contact of switch S1 and to the "B" section of operational follower IC1 which is set to a ten to one voltage gain (20dB). The 20dB step and vernier gain adjustment are provided so that automatic RF level programming may be used with both high and low level tuners, without using external active DC probes.

The signal at the common contact of X10 GAIN switch S1 is capacitively coupled to the potentiometric amplifier comprised of FET transistors Q3 and Q4 and operational amplifier IC2A. Q5,which saturates when the positive blanking square wave is applied to its base, is provided to remove unwanted noise at RF off time, and BAL control R14 adjusts for zero volt base line trace. The output signal is applied to the (inverted) contact of POLARITY switch S2 and to the inverting input of IC2B, which is set for a gain of one. The inverted signal is fed to the (normal) contact of the POLARITY switch. A positive response pattern is selected for the proper operation of the automatic level circuits. This permits the use of detectors of either polarity in the test set-up without requiring the use of external polarity inverting amplifiers.

The signal at the common contact of POLARITY switch is fed through R27 and pin 9 to the Front Panel SCOPE VERT output jack. Markers from pin 7 are combined with the output signal through C5.

RF LEVEL INDICATOR PULSE CIRCUITRY

The RF Level Program is fed to pin 6 and applied to the inverting input of operational amplifier IC3B, which is connected so as to convert the -18 to 0 volt RF level program to a +1 to 0 volt program when it is combined with the demodulated output signal at the junction of R27 and pin 9.

The RF Blanking Square Wave from pin 10 is differentiated by capacitor C8 and resistor R32 and is applied to the base of transistor Q6. Q6 inverts and amplifies the positive rising leading spike derived from the start of retrace (RF off) time. The negative going pulse output from the collector of Q6 is differentiated by C9 and R34. The negative going leading spike is used to trigger the integrated circuit timer IC5. The trigger sets a multivibrator, which releases a short circuit around capacitor C10. C10 charges to a positive voltage at an exponential rate determined by the RC time constant of the capacitor and R35. When C10 has charged to 2/3 of the timer's B+ supply voltage the multivibrator resets quickly discharging the capacitor. The timer output voltage is less than 1/4 volt positive before it is triggered and over 10 volts positive during the changing time of C10. The high positive voltage overides the negative bias on the gate of the FET switch transistor Q7, turning it on. When Q7 conducts, the converted level program voltage at R39, described earlier, is transfered to pin 9. The result is a vertical pedestal or pulse on the retrace base line located at the extreme right hand side of the scope display.

The pulse amplitude varies directly with the RF level program amplitude with a high amplitude pulse indicating a high RF output.

FREQUENCY INDICATOR PULSE CIRCUITRY

The frequency (tuning) program at pin 6 is inverted by operational amplifier IC3A. The inverted program is fed to the comparator operational amplifier IC4B that produces an output pulse starting and terminating at the points in time when the inverted frequency tuning program voltage level equals the triangle wave voltage from pin 4. Potentiometer R47 adjusts the amplitude of the triangle wave form and R43 adjusts the offset level at the comparison point.

The output of comparator IC4B is differentiated by C14 and R48. Diode CR3 removes the positive spike. The negative going spike triggers the integrated circuit timer IC6, which functions in the same way that the level indicator pulse timer, IC5, does as described above. The RC time constant of C16 and R50 establishes the duration of the positive pulse output. The timer output pulse is differentiated by C18 and R52 and combined with the demodulated output through R54. Since the timer is triggered by the negative spike only, the frequency indicator appears only on the retrace base line as a narrow, differentiated pulse that moves across the base line in step with the tuning voltage program.

SECTION 5 MAINTENANCE

5.1 INTRODUCTION

This section provides information for testing, calibrating, and trouble shooting the Sweep Generator. The performance test is designed for incoming inspection and periodic evaluation. If performance is not to specifications, refer to the calibration and trouble shooting sections.

5.2 SERVICE INFORMATION

5.2.1 Disassembly Information

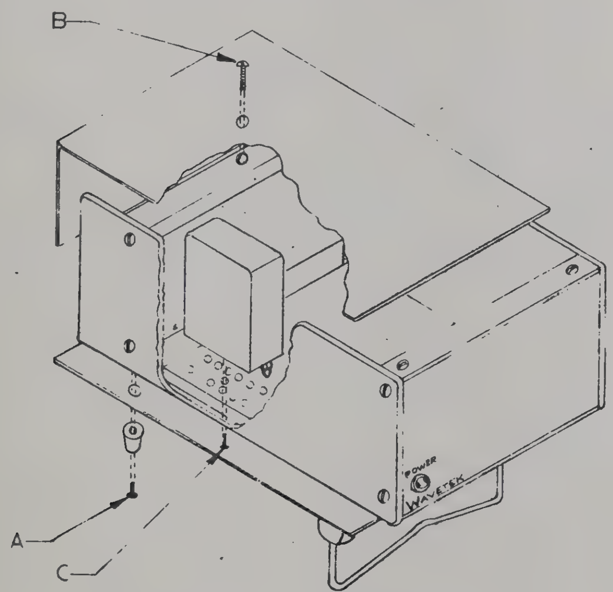


Figure 5-1. Disassembly

REMOVAL OF BOTTOM COVER - Remove the two rear feet (A) and lift cover off with a slight rear movement.

REMOVAL OF TOP COVER - Remove the single screw (B) from the top and lift off cover with a slight rear movement.

REMOVAL OF SIDE PANEL - Either side panel can be removed to provide better access by removing the four screws holding the side panel to the instrument. The Front Panel/Module Section can be removed from the power supply section by removing two screws holding the sections together and by disconnecting the electrical connectors between the two sections. NOTE: Separation of the two sections performs no useful purpose during normal service procedures.

5.2.2 Module Servicing

SERVICE KIT K102 - This kit contains a module extender and RF extension cables which enables the module to be electrically operated while physically located above the rest of the modules, thereby making all parts easily accessible.

REMOVAL OF MODULE - Modules may be removed by removing any cables attached to the top of the module and removing the hold-down screw (C) from the bottom. Pushing up on the module ball studs will help free the ball studs from the chassis mounted spring clips.

REMOVAL OF MODULE COVER - Remove all nuts and screws from top of module and slide the cover off.

REINSTALLING MODULE - Before reinstalling the module, check the module pins for proper alignment, then carefully seat the module pins into the chassis socket and replace the hold-down screw (C) to ensure a good ground connection between module and chassis.

MODULE PIN NUMBERING SYSTEM - The module pins are numbered as shown in Figure 5-2. The ball studs for the circuit modules are located off center to prevent the module's being plugged in backwards. This off-center ball stud location also provides a method for locating pin No. 1.

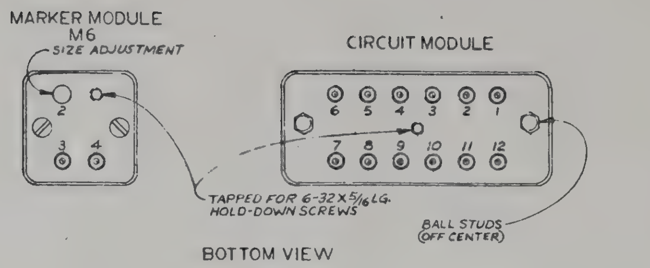


Figure 5-2. Module Pin Numbering System

5.2.3 Transistor Lead Configuration - Transistor lead configurations are shown in Figure 5-3.

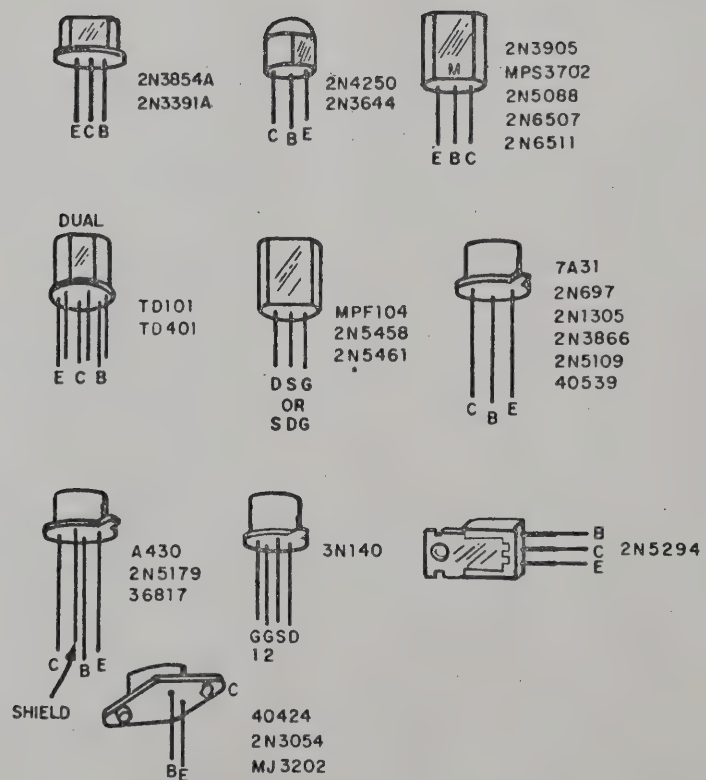
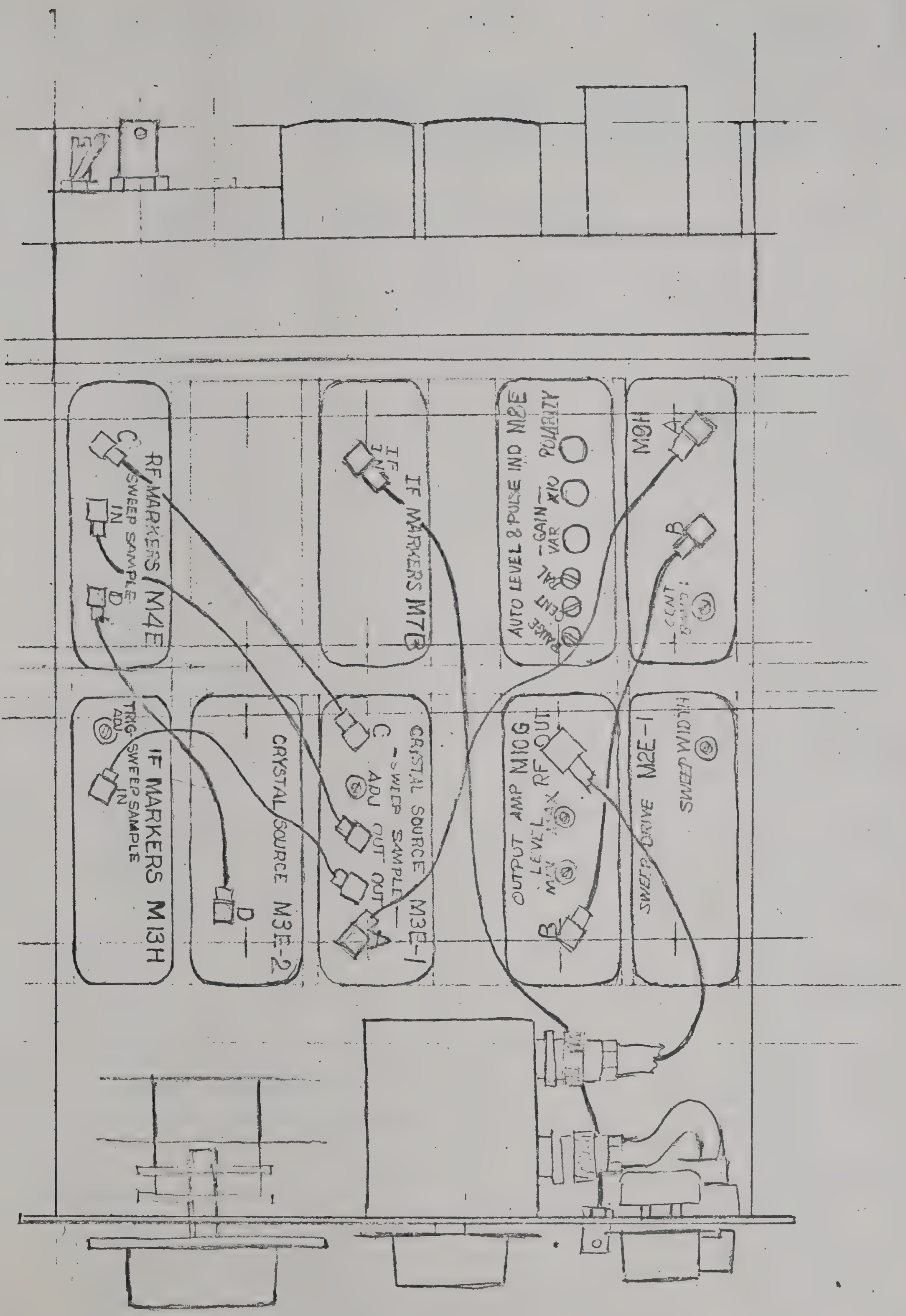


Figure 5-3. Transistor Lead Configuration

1402


RF MARKERS M4E
SWEEP SAMPLE
IN
C
D
IF MARKERS M7B
IF IN
AUTO LEVEL & PULSE IND M8E
POLARITY
GAIN
X10
VAR
CAL
CENT
RANGE
M9H
A
B
IF MARKERS M13H
TRIG ADJ
SWEEP SAMPLE
IN
CRYSTAL SOURCE M3E-2
D
CRYSTAL SOURCE M3E-1
SWEEP SAMPLE
ADJ OUT OUT
C
A
OUTPUT AMP M10G
RF OUT
LEVEL
MIN MAX
B
SWEEP DRIVE M2E-1
SWEEP WIDTH

SECTION 6
SCHEMATICS AND PARTS LIST

6.1 INTRODUCTION — This section contains all schematics and a list of replaceable parts for the instrument. Parts lists are located on the reverse side of the associated schematics.

6.2 MANUFACTURER'S CODE — The following code is used on the parts list to identify the manufacturer.

A-B	Allen-Bradley	Milwaukee, Wisconsin
A-E	Arco-Elmenco	Great Neck, New York
AER	Aerovox	New Bedford, Massachusetts
ALC	Alco Electronic Products Inc.	Lawrence, Massachusetts
AMP	AMP, Inc.	Harrisburg, Pennsylvania
APL	Amphenol	Danbury, Conn.
APX	Amperex	Slatersville, R. I.
BEK	Beckman Instruments, Inc.	Fullerton, California
BEL	Belden	Chicago, Illinois
BOU	Bourns	Riverside, California
BUS	Bussman	St. Louis, Missouri
CAM	Cambion	Cambridge, Massachusetts
C-D	Cornell Dubilier	Newark, New Jersey
CGW	Corning Glass Works	Corning, New York
C-J	Cinch Jones	Elk Grove Village, Illinois
C-K	C & K Components	Watertown, Massachusetts
C-L	Centralab	Milwaukee, Wisconsin
CTS	Chicago Telephone Systems	Elkhart, Indiana
C-W	Continental Wire	Philadelphia, Pennsylvania
DIO	Diodes, Inc.	Chatsworth, California
DRA	Drake Mfg. Company	Harwood Heights, Illinois
ETP	Erie Technological Prod. Inc.	Erie, Pennsylvania
FCD	Fairchild	Mountain View, California
G-E	General Electric	Syracuse, New York
G-H	Grayhill	La Grange, Illinois
HHS	Herman H. Smith, Inc.	Brooklyn, New York
H-P	Hewlett-Packard	Palo Alto, California
HEY	Heyman Mfg. Company	Kenilworth, New Jersey
IRC	International Resistance Co.	Philadelphia, Pennsylvania
ITT	International Telephone & Telegraph	West Palm Beach, Florida
JEF	Jeffers	Dubois, Pennsylvania
KID	Kidco, Inc.	Medford, New Jersey
LIT	Littelfuse	Des Plaines, Illinois
MAL	Mallory	Indianapolis, Indiana
M-O	Marko-Oak	Anaheim, California
MOL	Molex	Downers Grove, Illinois
MOT	Motorola	Phoenix, Arizona
P-B	Potter & Brumfield	Princeton, Indiana
POM	Pomona Electronics Co., Inc.	Pomona, California
Q-C	Quality Components	St. Marys, Pennsylvania
RCA	Radio Corporation of America	Harrison, New Jersey

RMC	Radio Material Company	Chicago, Illinois
SCC	Stackpole Carbon Co.	St. Marys, Pennsylvania
SEL	Selectro	Mamaroneck, New York
SEM	Semtech	Newbury Park, California
SIG	Signetics Corporation	Sunnydale, California
S-I	Switchcraft, Inc.	Chicago, Illinois
SPR	Sprague	North Adams, Massachusetts
S-T	Sarkes Tarzian	Bloomington, Indiana
STR	Stettner & Co.	Nurnburg, Western Germany
SYL	Sylvania	Woburn, Massachusetts
THR	Thermalloy, Co.	Dallas, Texas
TRW	TRW Capacitor Division	Ogallala, Nebraska
W-E	Wells Electronics	South Bend, Indiana
W-I	Wavetek, Indiana, Inc.	Indianapolis, Indiana
WSD	Wavetek, San Diego	San Diego, California

6.3 SCHEMATIC NOTES

6.3 SCHEMATIC NOTES — The following notes and abbreviations pertain to all schematics. Additional notes pertaining to specific schematics are included on each schematic if required.

All resistor values are shown in "ohms" unless otherwise specified.
All capacitor values are shown in picofarads "pF" unless otherwise specified.
All inductor values are shown in microhenries "uH" unless otherwise specified.

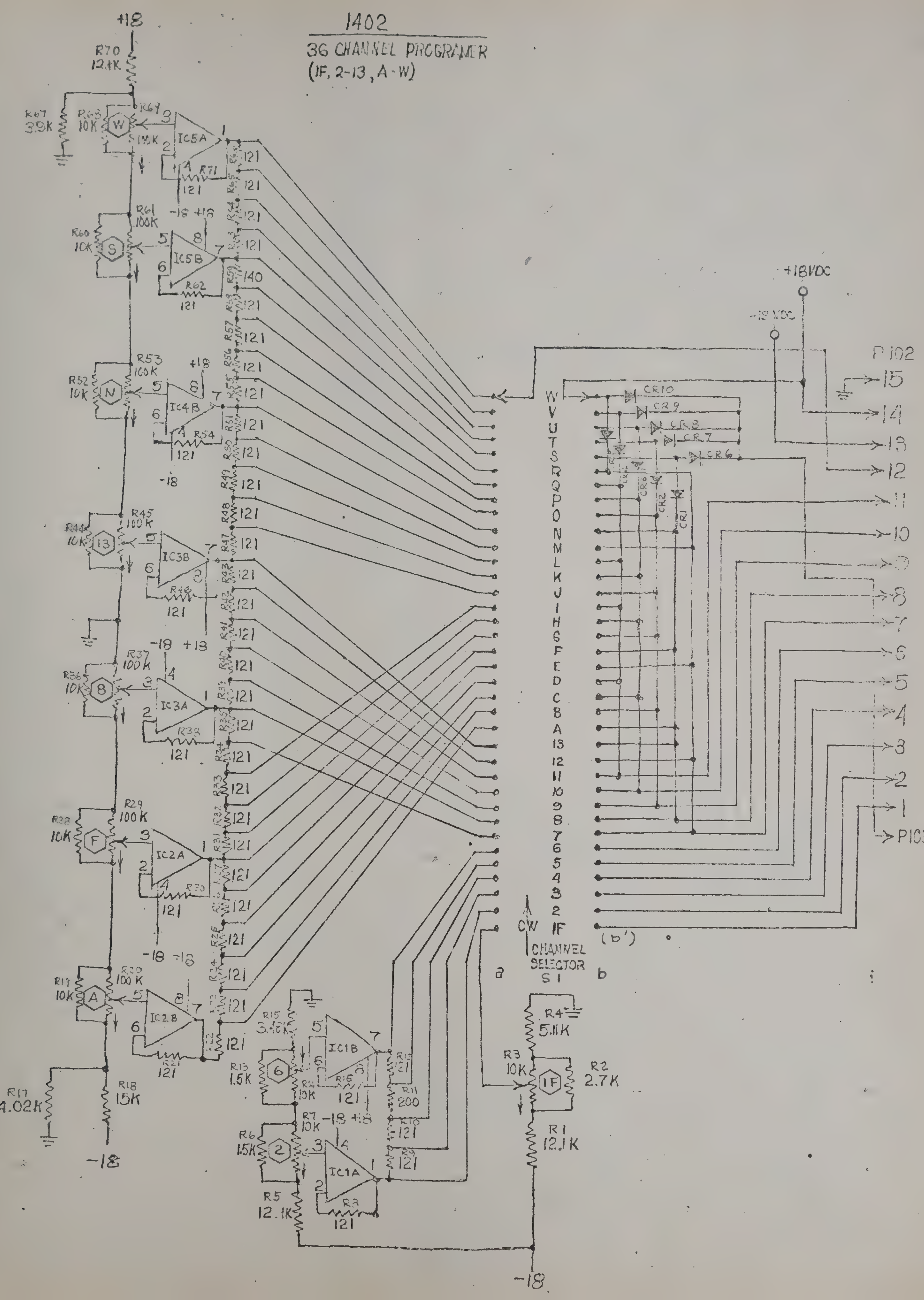
- Denotes DC voltage reading in volts unless otherwise specified.
- Denotes high impedance crystal detector reading in volts unless otherwise specified.
- 12 Denotes 50ohm crystal detector reading in volts unless otherwise specified.
- Signal or voltage source
- Connect to indicate signal or voltage source
- Arrow indicates clockwise rotation of wiper
- Coaxial jack
- Coaxial plug
- Coaxial cable
- * Factory adjusted part

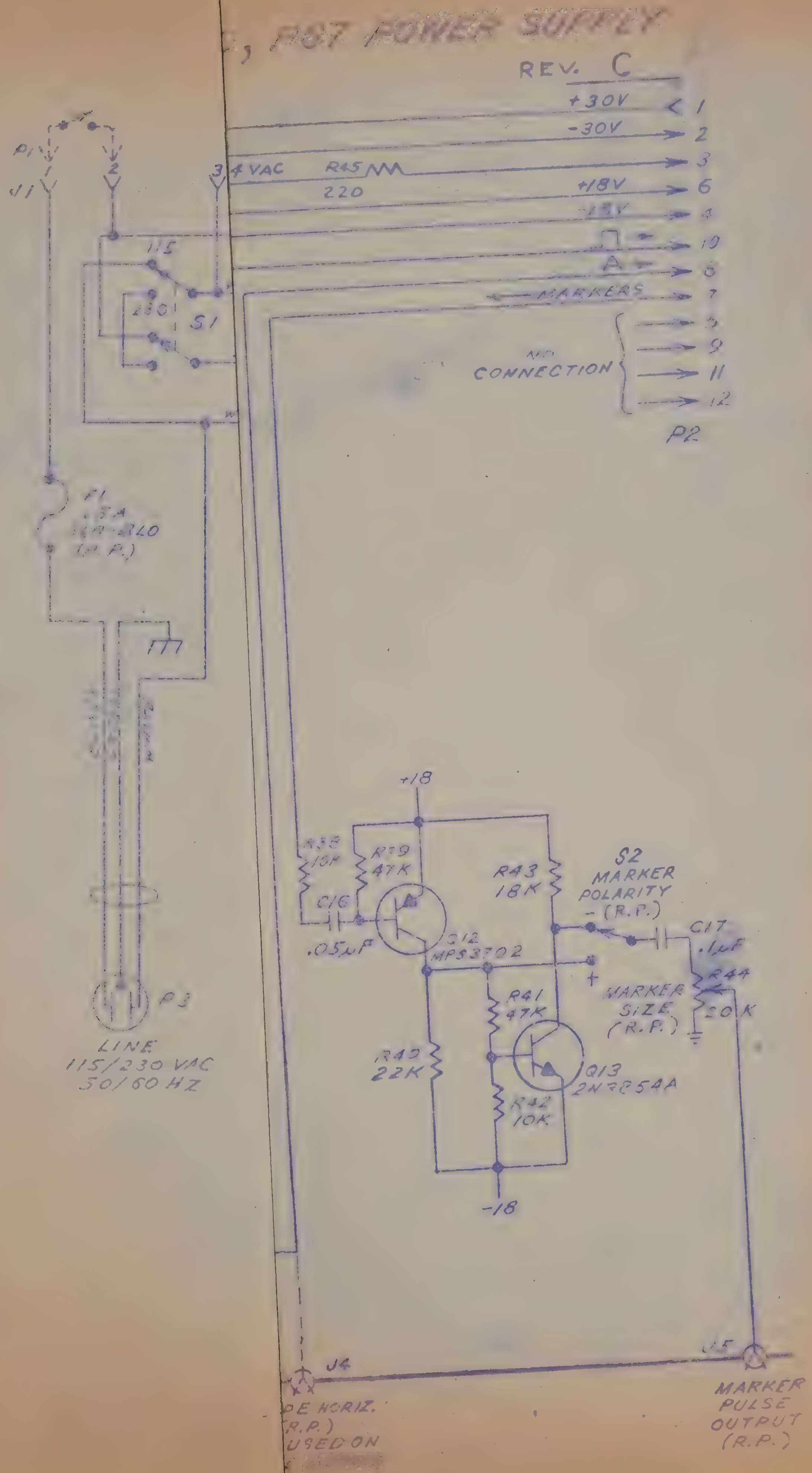
6.4 ABBREVIATION CODE

A	ampere
ac	alternating current
C	capacitor
CR	diode
dB	decibel
dBm	decibel referred to 1mW
dc	direct current
DS	device indicating, lamp
F	farad
F.P.	front panel
H	henry
Har	harmonic
Hz	hertz
IC	integrated circuit
IF	intermediate frequency
kHz	kiloherz
Kohm	kilohm
kv	kilovolt
kW	kilowatt
L	inductor
MHz	megahertz
Mohm	megohm
uF	microfarad
uA	microampere
uH	microhenry
mA	milliampere
mH	millihenry
mV	millivolt
mW	milliwatt
Ω	ohm
p-p	peak to peak
pF	picofarad
Q	transistor
R	resistor
RF	radio frequency
rms	root-mean-square
R.P.	rear panel
S	switch
T	transformer
V	volt
VA	voltampere
W	watt
X	crystal

1402

36 CHANNEL PROGRAMER
(IF, 2-13, A-W)

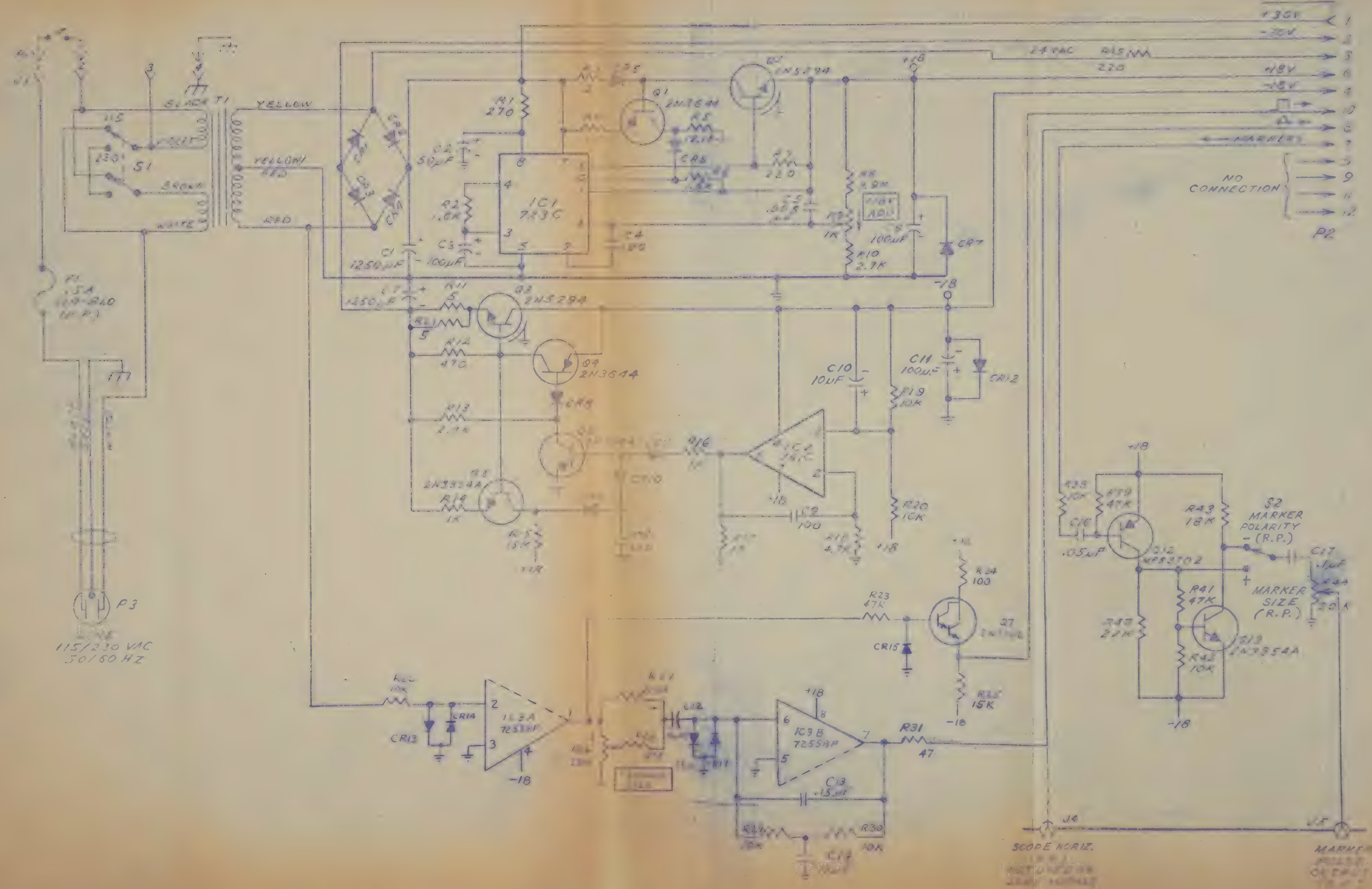


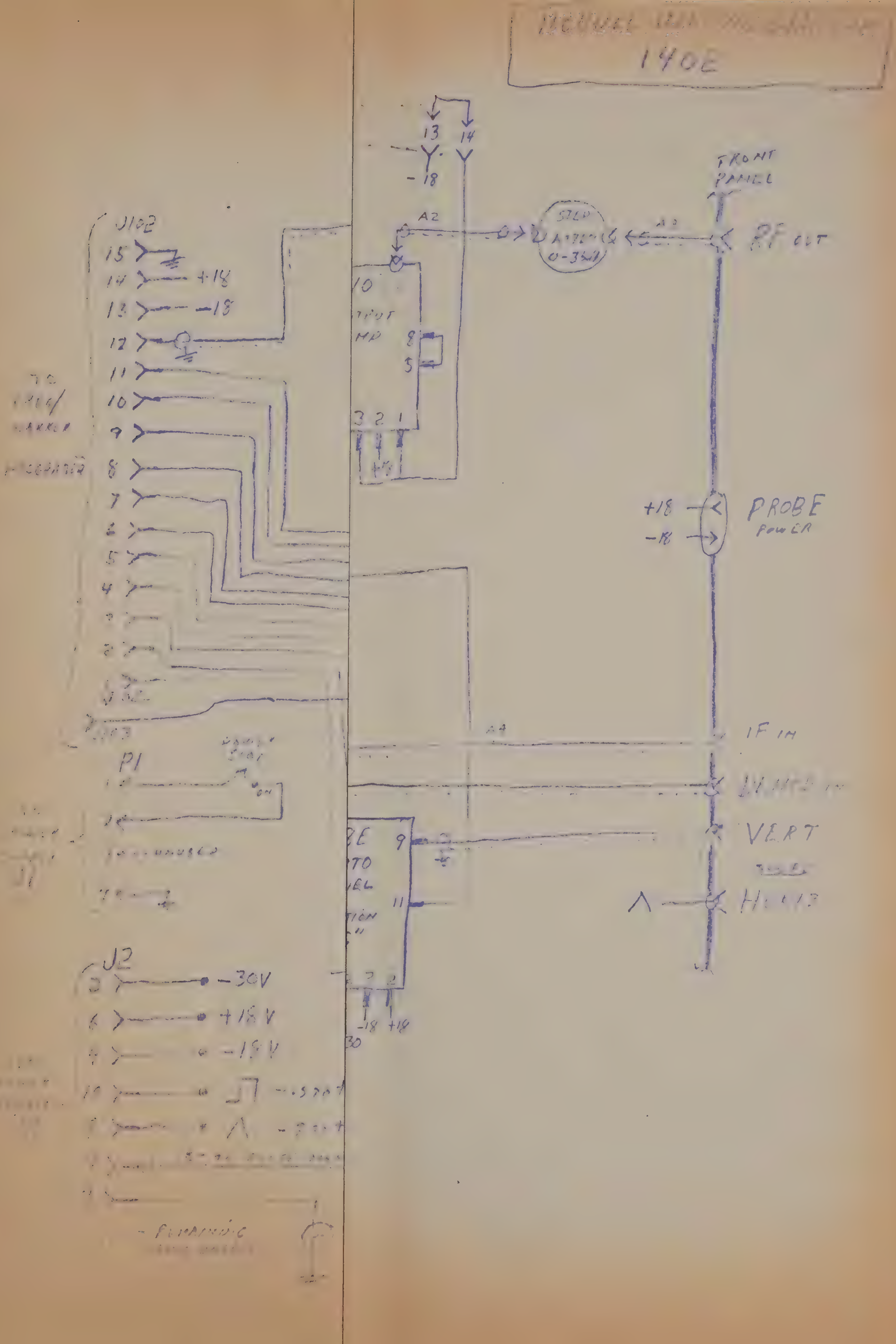


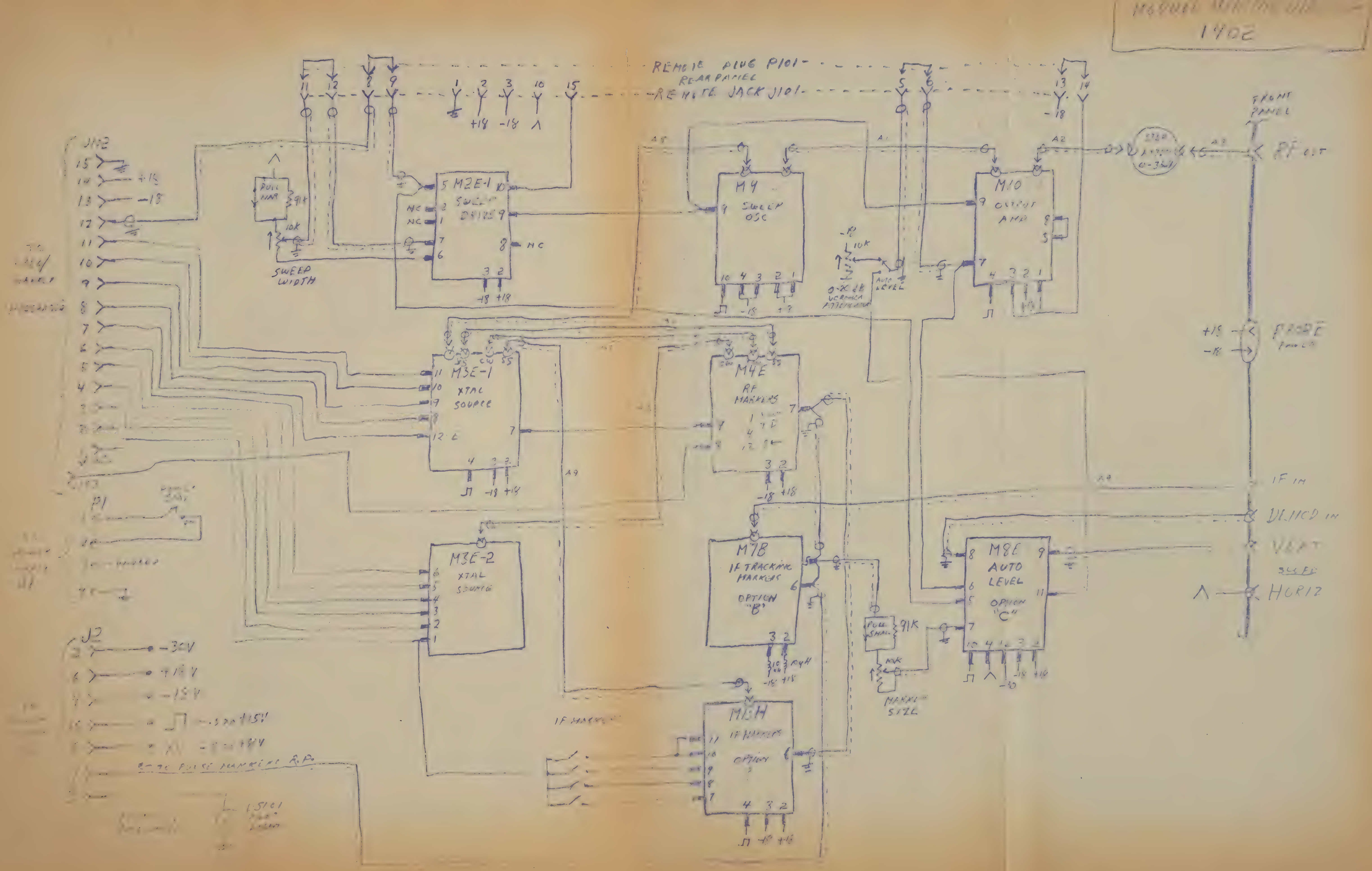
, P87 POWER SUPPLY
REV. C
+30V
-30V
R45
220
+18V
MARKERS
NO CONNECTION
P2
P1
J1
S1
115
230
F1
LINE
115/230 VAC
50/60 HZ
P3
+18
R38
R39
47K
C16
.05µF
Q12
MPS3702
R43
18K
S2
MARKER
POLARITY
(R.P.)
C17
.1µF
R44
MARKER
SIZE
(R.P.)
R41
47K
R40
22K
Q13
R42
10K
-18
J4
J5
MARKER
PULSE
OUTPUT
(R.P.)
USED ON

SCHEMATIC, PS7 POWER SUPPLY

REV. C



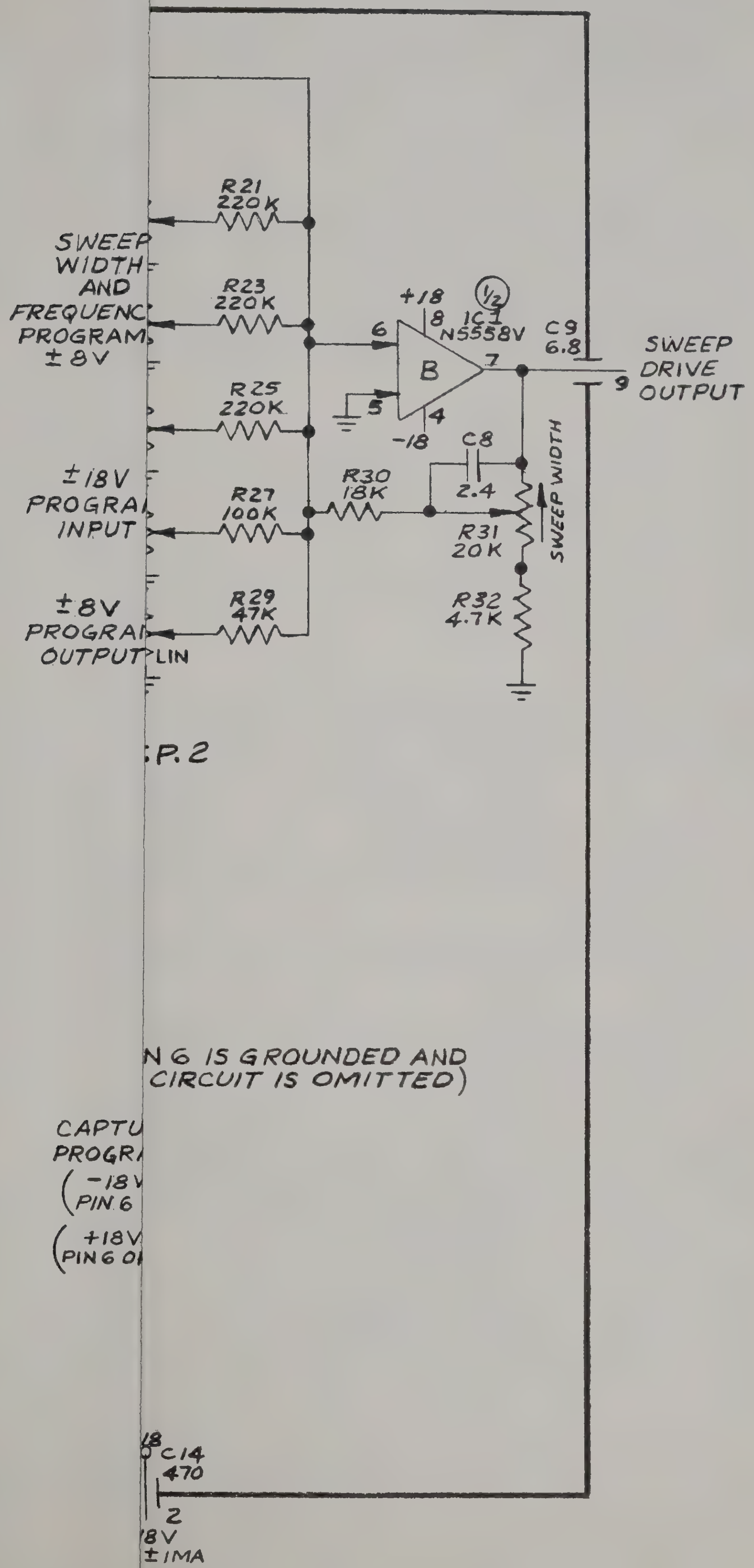

140E
13
14
-18
FRONT
PANEL
A2
RF OUT
J102
+18
-18
PROBE
POWER
IF IN
VERT
P1
J2
-30V
+18V
-18V
-18
+18



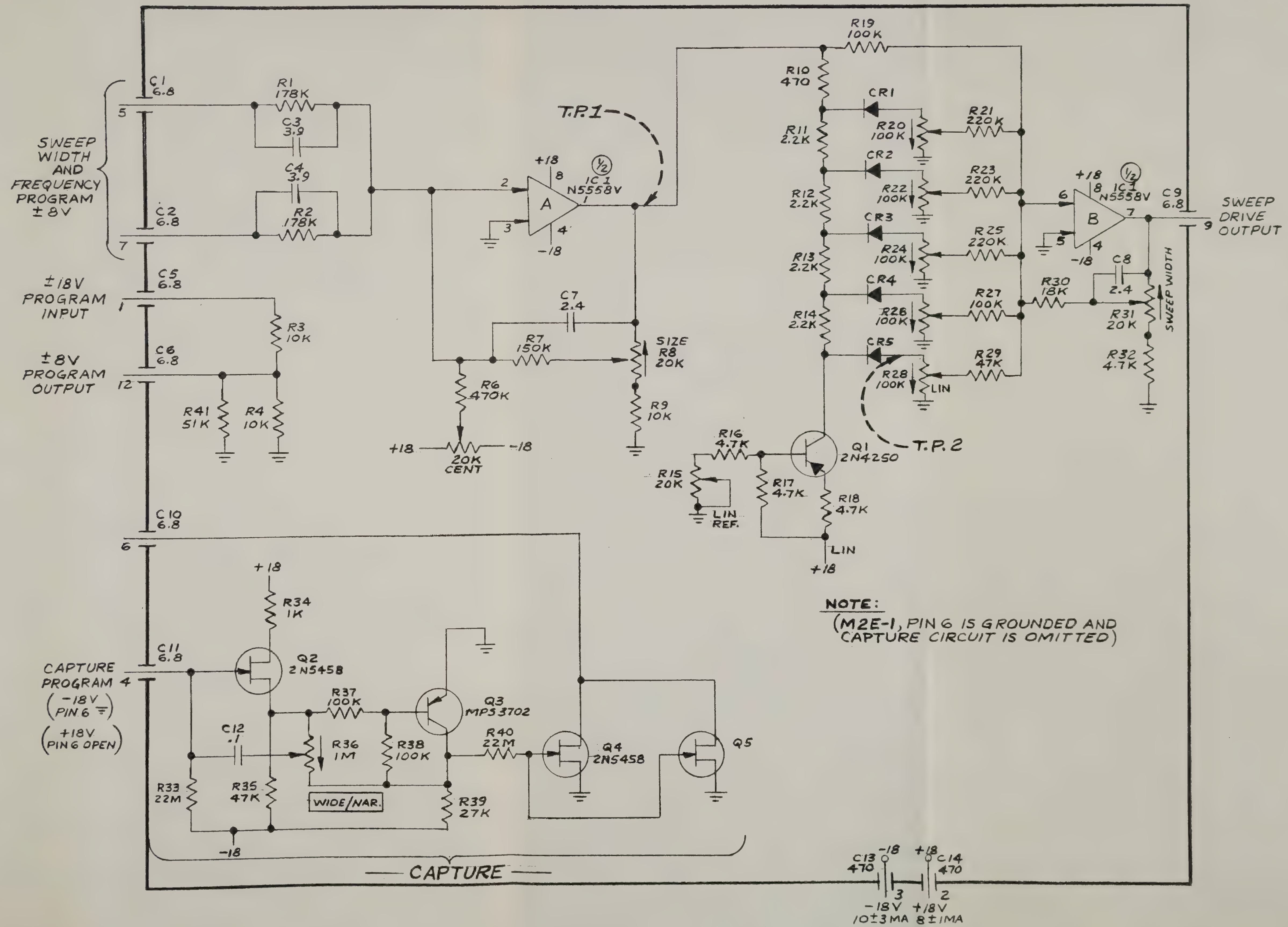
1402
REMOTE PLUG P101
REAR PANEL
REMOTE JACK J101
J102
SWEEP WIDTH
M2E-1
SWEEP DRIVE
M4
SWEEP OSC
M10
OUTPUT AMP
FRONT PANEL
RF OUT
0-20 dB
AUTO LEVEL
M3E-1
XTAL SOURCE
M4E
RF MARKERS
M3E-2
XTAL SOURCE
M7B
IF TRACKING MARKERS
OPTION "B"
M8E
AUTO LEVEL
OPTION "C"
IF IN
DETECT IN
VERT
HORIZ
MARKER SIZE
IF MARKERS
M13H
IF MARKERS
OPTION
P1
J2
-30V
+18V
-18V

SWEEP DRIVE SCHEMATIC
MODULE M2E (M2E-1)

REV. A



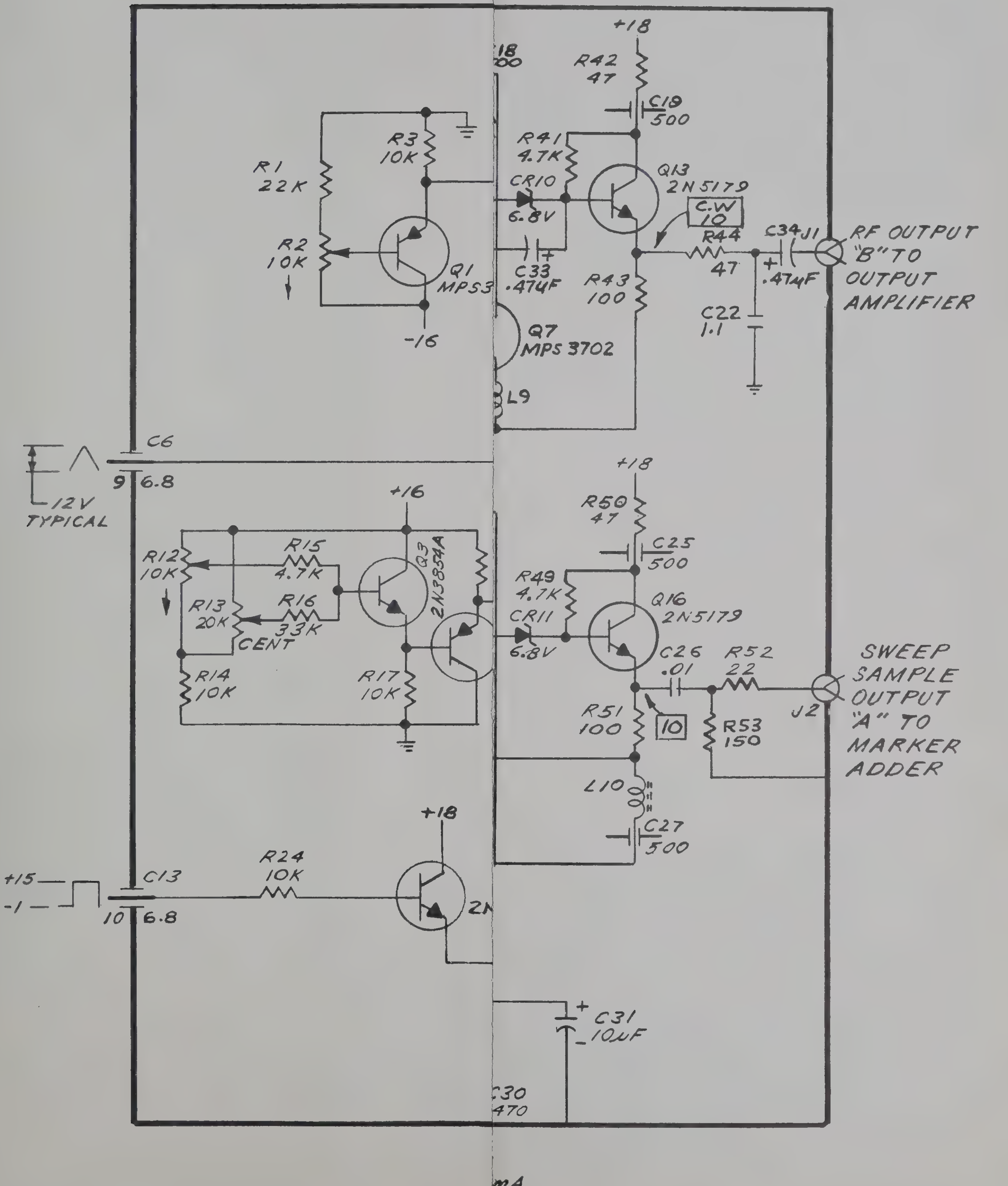
SWEEP DRIVE SCHEMATIC
MODULE M2E (M2E-1)
REV. A



NOTE:
(M2E-1, PIN 6 IS GROUNDED AND CAPTURE CIRCUIT IS OMITTED)

ATOR-MIXER SCHEMATIC
MODULE M9G & M9H

REV C



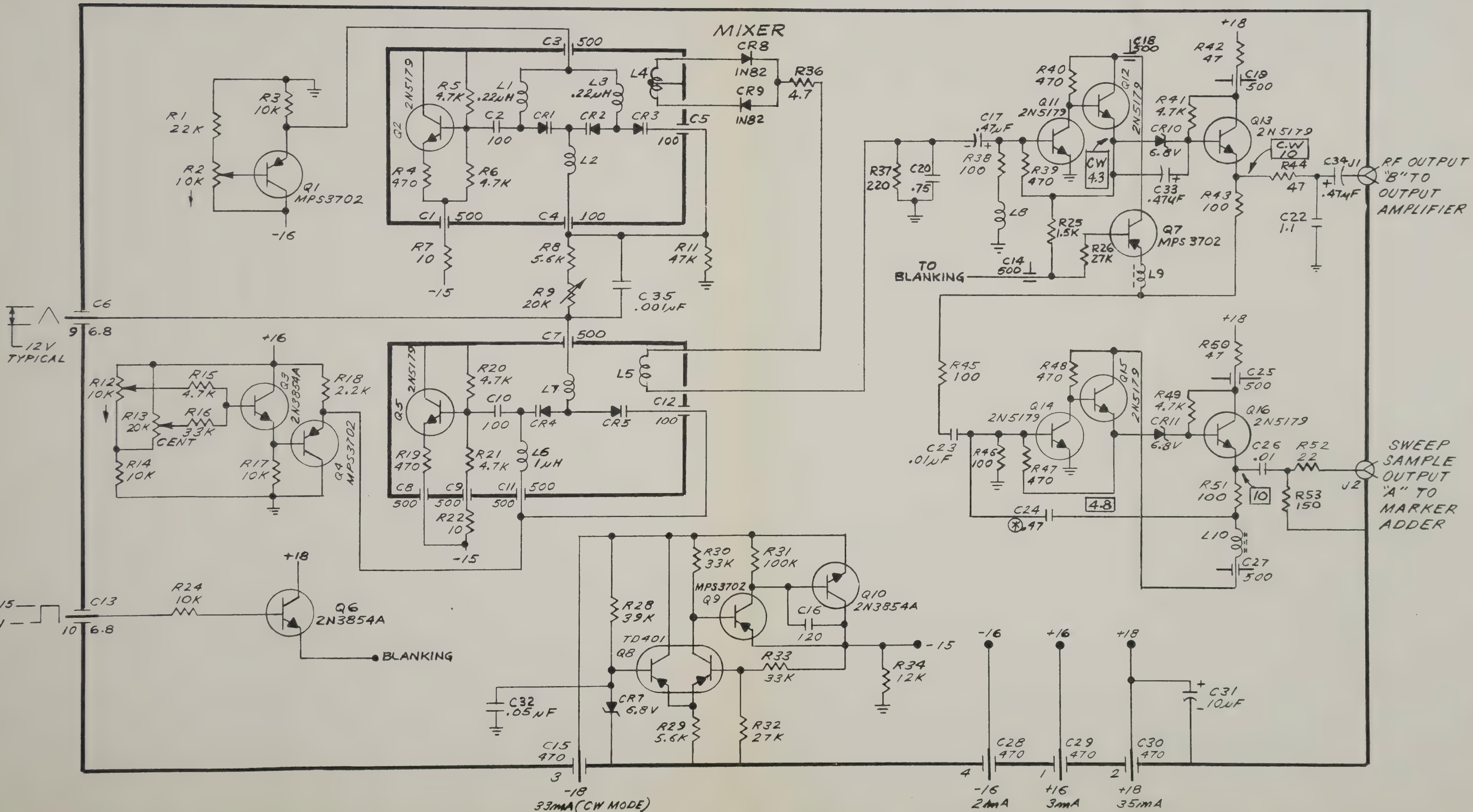
PARTS LIST

MODULE M2E REV A

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
" C "	CAPACITORS				
1,2,5,6,9, 10, 11	Ceramic feedthru 6.8pF ±10% 500 V	CF-102-R68	A-B	FA5C	7
3,4	Composition, 3.9pF ±10% 500 V	CG-101-239	Q-C	QC3.9	2
7,8	Composition, 2.4pF ±10% 500 V	CG-101-224	Q-C	QC2.4	2
12	Ceramic disc., .1uF ±20% 100 V	CD-103-310	SPR	TG-P10	1
13,14	Ceramic feedthru 470pF ±20% 500 V	CF-101-147	A-B	FA5C	2
" CR "	DIODES				
1 to 5	Silicon, Junction, 100 p.i.V. 750mA	DR-000-001	ITR	1N4002	5
" IC "	INTEGRATED CIRCUITS				
1	Dual operational amplifier 8 pin in line	IC-000-005	SIG	N5558V	1
" R "	Resistors				
1,2	Metal film, 178 k ohm, matched set .1%	RX-000-005	W-I	RX-000-005	1
3,4	Metal film, 10 k ohm ±1% ¼W	RF-012-100	COR	RN60D	2
5,8,15,31	Variable, cermet, 20 k ohm ±10% 3/4W	RP-130-320	BEK	89PR20K	4
6	Fixed, comp., 470 k ohm ±10% ¼W	RC-104-447	A-B	CB4741	1
7	Fixed, comp., 150 k ohm ±10% ¼W	RC-104-415	A-B	CB1541	1
9	Fixed, comp., 10 k ohm ±10% ¼W	RC-104-310	A-B	CB1031	1
10,	Fixed, comp., 470 ohm ±10% ¼W	RC-104-147	A-B	CB4711	1
11,12,13,14	Fixed, comp., 2.2 k ohm ±10% ¼W	RC-104-222	A-B	CB2221	4
16,17,18,32					
19,27,37,38	Fixed, comp., 100 k ohm ±10% ¼W	RC-104-410	A-B	CB1041	4
20,22,24,26 28	Variable, cermet 100 k ohm ±10% 3/4W	RP-130-410	BEK	89PR100K	5
21,23,25	Fixed, comp., 220 k ohm±10% ¼W	RC-104-422	A-B	CB2241	3
29,35	Fixed, comp., 47 k ohm ±10% ¼W	RC-104-347	A-B	CB4731	2
30	Fixed, comp., 18 k ohm ±10% ¼W	RC-104-318	A-B	CB1831	1
33,40	Fixed, comp., 22 M ohm ±10% ¼W	RC-104-622	A-B	CB2261	2
34	Fixed, comp., 1 k ohm ±10% ¼W	RC-104-210	A-B	CB1021	1
36	Variable, cermet 1 M ohm ±10% 3/4W	RP-130-510	BEK	89PR1meg	1
39	Fixed, comp., 27 k ohm ±10% ¼W	RC-104-327	A-B	CB2731	1
41	Fixed, comp., 51 k ohm ± 5% ¼W	RC-103-351	A-B	CB5135	1
" Q "	Transistors				
1	P.N.P. Silicon	QA-042-500	FCD	2N4250	1
2,4 ,5	N Channel JFET	QA-054-580	MOT	2N5458	3
3	P.N.P. Silicon	QB-000-009	MOT	MPS3702	1

OSCILLATOR-MIXER SCHEMATIC
MODULE M9G & M9H

REV C



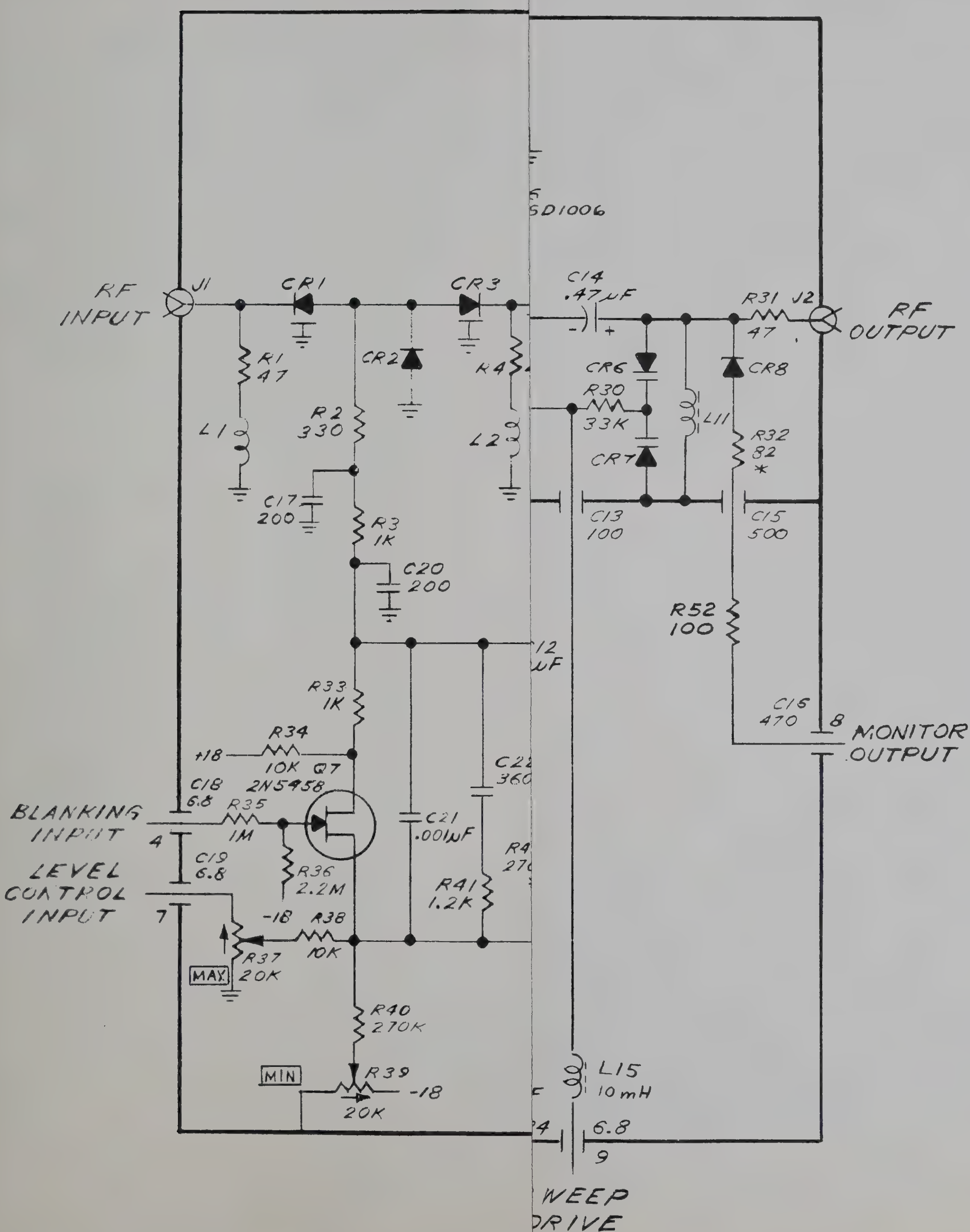
PARTS LIST

MODULE M9G M9H REV C

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"R "	RESISTORS				
18	Fixed, comp., 2.2kohm ±10% ¼W	RC-104-222	A-B	CB2221	1
25	Fixed, comp., 1.5kohm ±10% ¼W	RC-104-215	A-B	CB1521	1
26	Fixed, comp., 27kohm ±10% ¼W	RC-104-327	A-B	CB2731	1
28	Fixed, comp., 39kohm ±10% ¼W	RC-104-339	A-B	CB3931	1
31	Fixed, comp., 100kohm ±10% ¼W	RC-104-410	A-B	CB1041	1
32	Fixed, comp., 27kohm ± 5% ¼W	RC-103-327	A-B	CB2735	1
33	Fixed, comp., 33kohm ± 5% ¼W	RC-103-333	A-B	CB3335	1
34	Fixed, comp., 12kohm ±10% ¼W	RC-104-312	A-B	CB1231	1
36	Fixed, comp., 4.7ohm ±10% ¼W	RC-104-R47	A-B	CB47G1	1
37	Fixed, comp., 220ohm ±10% ¼W	RC-104-122	A-B	CB2211	1
38,43,45,46, 51	Fixed, comp., 100ohm ±10% ¼W	RC-104-110	A-B	CB1011	5
42,44,50	Fixed, comp., 47ohm ±10% ¼W	RC-104-047	A-B	CB4701	3
52	Fixed, comp., 22ohm ±10% ¼W	RC-104-022	A-B	CB2201	1
53	Fixed, comp., 150ohm ±10% ¼W	RC-104-115	A-B	CB1511	1
"Q "	TRANSISTORS				
1,4,5,9	PNP, Silicon,	QB-000-009	MOT	MPS3702	4
2,6,11,12,13, 14,15,16	NPN, Silicon,	QA-051-790	RCA	2N5179	8
3,7,10	NPN, Silicon,	QA-038-541	G-E	2N3854A	3
8	PNP, Silicon, dual	QB-000-011	SPR	TD401	1

AMPLIFIER SCHEMATIC
LE M10F & M10G

REV C



PARTS LIST

MODULE M9G M9H REV C

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"C "	CAPACITORS				
1,3,7,8,9,	Ceramic feedthru, 500pF ±20% 250V	CF-104-150	AER	EF4	11
11,14,18,19,					
25,27					
2,10	Ceramic disc, 100pF ±10% 1kV	CD-108-110	RMC	C,N750	2
5,12,4	Ceramic feedthru, 100pF ±20% 250V	CF-104-110	AER	EF4	3
6,13	Ceramic feedthru, 6.8pF ±10% 500V	CF-102-R68	A-B	FA5C	2
15,28,29,30	Ceramic feedthru, 470pF ±20% 500V	CF-101-147	A-B	FA5C	4
16	Ceramic disc, 120pF ±20% 1kV	CD-102-112	SPR	5GAT12	1
17,33,34	Electrolytic, .47uF 50V	CE-113-447	TRW	935	3
20	Composition, .75pF ±10% 500V	CG-101-175	Q-C	QC.75	1
21	Factory adjusted, nominal value shown	Not Assign.	---	--------	--
22	Composition, 1.1uF ±10%, factory adj.	CG-101-211	Q-C	QC1.1	1
23,26	Ceramic disc, .01uF ±20% 100V	CD-103-310	SPR	TGS10	2
24	Factory adjusted, nominal value shown	Not Assign.	---	--------	--
31	Electrolytic, 10uF 25V	CE-105-010	SPR	TE1204	1
32	Ceramic disc, .05uF ±20% 100V	CD-103-350	SPR	TGS50	1
35	Ceramic disc, .001uF ± 20% 1kV	CD-102-210	SPR	5GAD10	1
"J "	CONNECTORS				
1,2	Jack, receptacle, 50ohm, submin.	JF-000-005	APL	27-9	2
"CR "	DIODES				
1,2,3,4,5	Voltage variable capacitance	DC-000-005	W-I	DC-000-005	5
6	Not assigned	----------	---	---------	--
7,10,11	Zener, 6.8V	DB-000-001	C-L	HW-6.8	3
8,9	Silicon, point contact	DG-100-821	SYL	IN82AS	2
"L "	INDUCTORS				
1,3	Fixed, .22uH	LA-005-R02	W-E	506	2
2,7	Fixed ------	Not Assign.	W-I	----------	--
4	Fixed ------	Not Assign.	W-I	----------	--
5	Fixed ------	Not Assign.	W-I	----------	--
6	Fixed 1uH	LA-005-R10	W-E	506	1
8	Fixed ------	Not Assign.	W-I	----------	--
9,10	Fixed ------	LA-006-004	W-I	LA-006-004	2
"R "	RESISTORS				
1	Fixed, comp., 22kohm ±10% ¼W	RC-104-322	A-B	CB2231	1
2,12	Variable,cermet, 10kohm ±20%	RF-129-310	CTS	360S103B	2
3,14,17,24	Fixed, comp., 10kohm ±10% ¼W	RC-104-310	A-B	CB1031	4
4,19,39,40,	Fixed, comp., 470ohm ±10% ¼W	RC-104-147	A-B	CB4711	6
47,48					
5,6,15,20,21,	Fixed, comp., 4.7kohm ±10% ¼W	RC-104-247	A-B	CB4721	7
41,49					
7,22,	Fixed, comp., 10ohm ±10% ¼W	RC-104-010	A-B	CB1001	2
8,29	Fixed, comp., 5.6kohm ±10% ¼W	RC-104-256	A-B	CB5621	2
9	Variable, cermet, 20kohm ±10%	RP-129-320	CTS	360S203B	1
10,23,27,35	Not Assigned	----------	---	----------	--
11	Fixed, comp., 47kohm ±10% ¼W	RC-104-347	A-B	CB4731	1
13	Variable, carbon, 20kohm ±20%	RP-124-320	A-B	WA2G032	1
16, 30	Fixed, comp., 33kohm ±10% ¼W	RC-104-333	A-B	CB3331	2

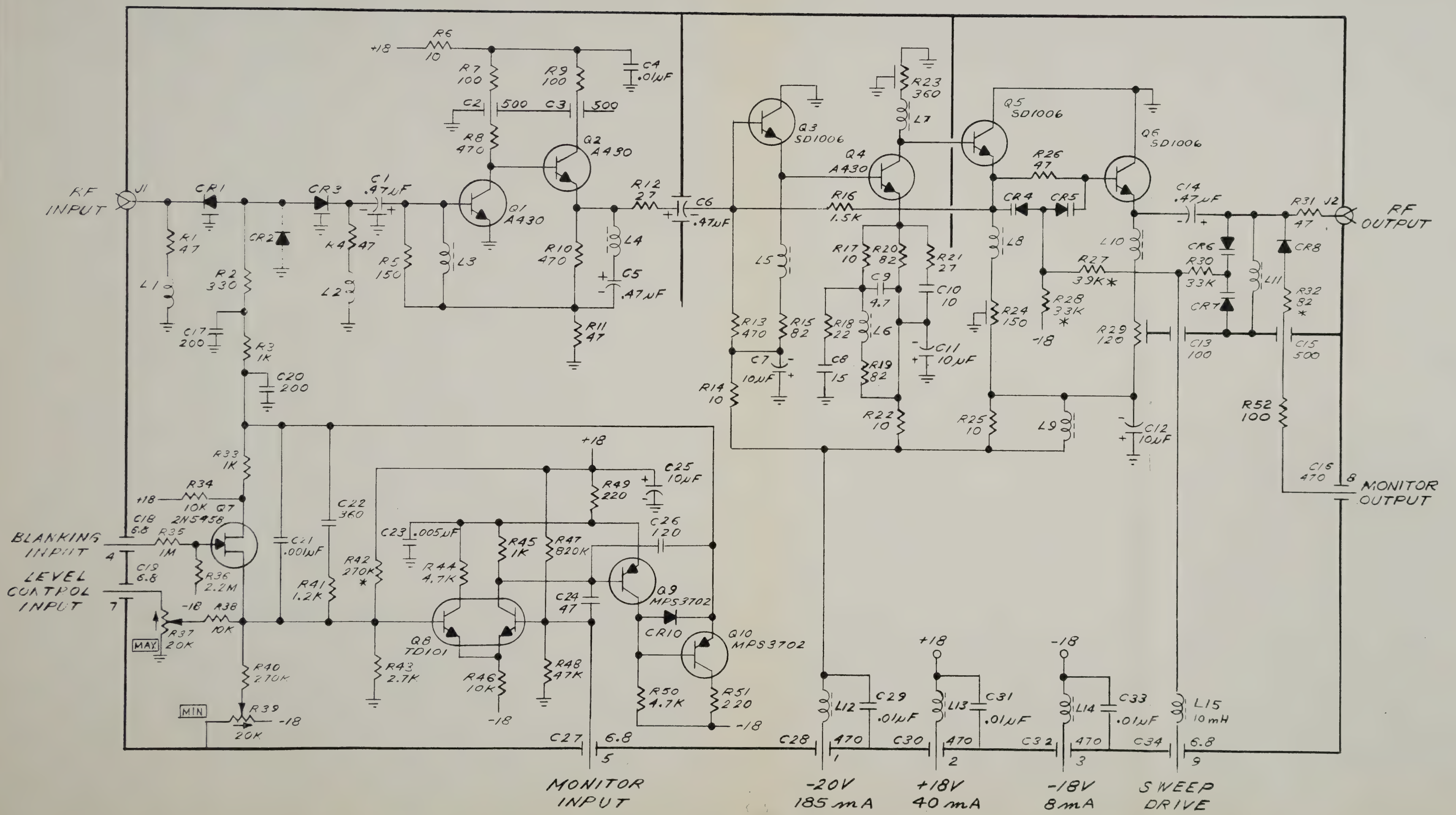
PARTS LIST

MODULE M9G M9H REV C

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"R "	RESISTORS				
18	Fixed, comp., 2.2kohm ±10% ¼W	RC-104-222	A-B	CB2221	1
25	Fixed, comp., 1.5kohm ±10% ¼W	RC-104-215	A-B	CB1521	1
26	Fixed, comp., 27kohm ±10% ¼W	RC-104-327	A-B	CB2731	1
28	Fixed, comp., 39kohm ±10% ¼W	RC-104-339	A-B	CB3931	1
31	Fixed, comp., 100kohm ±10% ¼W	RC-104-410	A-B	CB1041	1
32	Fixed, comp., 27kohm ± 5% ¼W	RC-103-327	A-B	CB2735	1
33	Fixed, comp., 33kohm ± 5% ¼W	RC-103-333	A-B	CB3335	1
34	Fixed, comp., 12kohm ±10% ¼W	RC-104-312	A-B	CB1231	1
36	Fixed, comp., 4.7ohm ±10% ¼W	RC-104-R47	A-B	CB47G1	1
37	Fixed, comp., 220ohm ±10% ¼W	RC-104-122	A-B	CB2211	1
38,43,45,46,	Fixed, comp., 100ohm ±10% ¼W	RC-104-110	A-B	CB1011	5
51					
42,44,50	Fixed, comp., 47ohm ±10% ¼W	RC-104-047	A-B	CB4701	3
52	Fixed, comp., 22ohm ±10% ¼W	RC-104-022	A-B	CB2201	1
53	Fixed, comp., 150ohm ±10% ¼W	RC-104-115	A-B	CB1511	1
"Q "	TRANSISTORS				
1,4,5,9	PNP, Silicon,	QB-000-009	MOT	MPS3702	4
2,6,11,12,13,	NPN, Silicon,	QA-051-790	RCA	2N5179	8
14,15,16					
3,7,10	NPN, Silicon,	QA-038-541	G-E	2N3854A	3
8	PNP, Silicon, dual	QB-000-011	SPR	TD401	1

OUTPUT AMPLIFIER SCHEMATIC
MODULE M10F & M10G

REV C



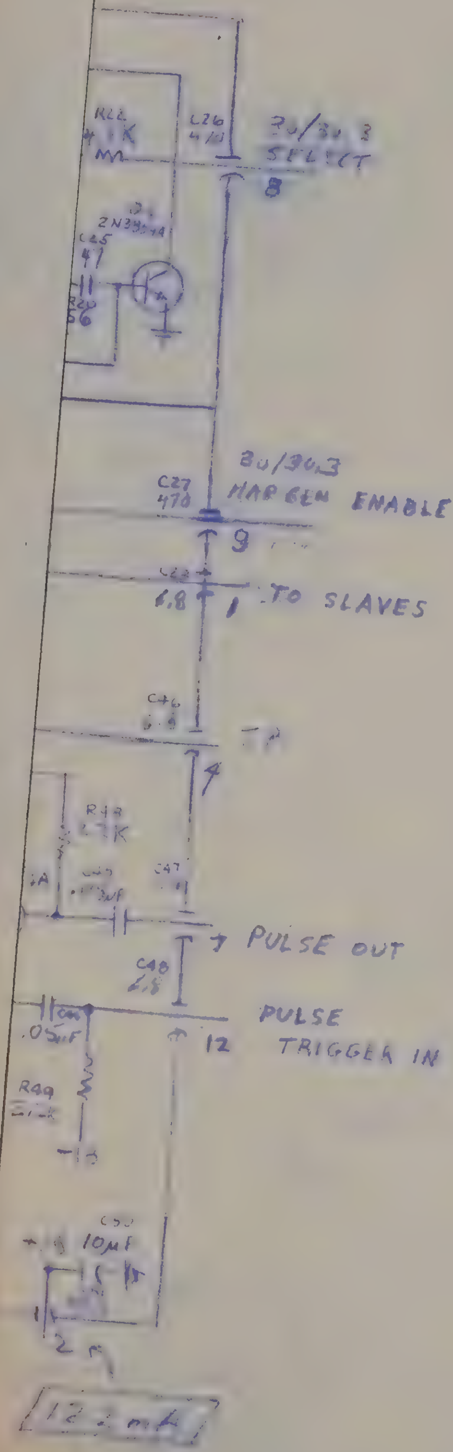
PARTS LIST

MODULE M10F M10G REV C

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"R "	RESISTORS				
18	Fixed, comp., 22ohm ±10% ¼W	RC-104-022	A-B	CB2201	1
23	Fixed, comp., 360ohm ±5% ½W	RC-105-136	A-B	EB3615	1
24	Fixed, comp., 150ohm ±5% 1W	RC-107-115	A-B	GB1515	1
27	Fixed, comp., 39kohm ±10% ¼W	RC-104-339	A-B	CB3931	1
28,30	Fixed, comp., 33kohm ±10% ¼W	RC-104-333	A-B	CB3331	2
29	Fixed, comp., 120ohm ±5% ½W	Rc-107-112	A-B	GB1215	1
31	Fixed, comp., 47ohm ±5% ¼W	RC-103-047	A-B	CB4705	1
32	Fixed, comp., 82ohm ±10% ¼W	RC-104-082	A-B	CB8201	1
34,38,46	Fixed, comp., 10kohm ±10% ¼W	RC-104-310	A-B	CB1031	3
35	Fixed, comp., 1Mohm ±10% ¼W	RC-104-510	A-B	CB1051	1
36	Fixed, comp., 2.2Mohm ±10% ¼W	RC-104-522	A-B	CB2251	1
37,39	Variable, carbon, 20kohm ±20% ¼W	RP-124-320	A-B	WA2G032	2
40,42	Fixed, comp., 270kohm ±10% ¼W	RC-104-427	A-B	CB2741	2
41	Fixed, comp., 1.2kohm ±10% ¼W	RC-104-212	A-B	CB1221	1
43	Fixed, comp., 2.7kohm ±10% ¼W	RC-104-227	A-B	CB2721	1
44,50	Fixed, comp., 4.7kohm ±10% ¼W	RC-104-247	A-B	CB4721	2
47	Fixed, comp., 820kohm ±10% ¼W	RC-104-482	A-B	CB8241	1
48	Fixed, comp., 47kohm ±10% ¼W	RC-104-347	A-B	CB4731	1
49,51	Fixed, comp., 220ohm ±10% ¼W	RC-104-122	A-B	CB2211	2
"Q "	TRANSISTORS				
1,2,4	NPN, Silicon	QB-000-013	AER	A430	3
3,5,6	NPN, Silicon	QB-000-018	SSS	SD 1006	3
7	N-channel, JFET, Silicon	QA-054-580	MOT	2N5458	1
8	NPN, Silicon, dual	QB-000-010	SPR	TD101	1
9,10	PNP, Silicon	QB-000-009	MOT	MPS3702	2

REV 11/14/72

8/22/72



PARTS LIST

MODULE M10F M10G REV C

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"C "	CAPACITORS				
1,5,6,14	Electrolytic, .47uF 50V	CE-113-447	TRW	935	4
2,3,15	Ceramic feedthru, 500pF ±20% 250V	CF-104-150	AER	EF4	3
4,29,31,33	Ceramic disc, .01 uF ±20% 100V	CD-103-310	SPR	TG-S10	4
7,11,12,25	Electrolytic, 10uF 25V	CE-105-010	SPR	TE1204	4
8	Ceramic disc, 15pF ±5% 1kV	CD-101-015	SPR	10TCC-Q15	1
9	Ceramic disc, 4.7pF ±5% 1kV	CD-101-R47	SPR	10TCC-V47	1
10	Ceramic disc, 10pF ±5% 1kV	CD-101-010	SPR	10TCC-Q10	1
13	Ceramic feedthru, 100pF ±20% 250V	CF-104-110	SPR	EF4	1
16,28,30,32	Ceramic feedthru, 470pF ±20% 500V	CF-101-147	A-B	FA5C	4
17,20	Ceramic disc, 200pF ±20% 1kV	CD-102-120	SPR	5GA-T20	2
18,19,27,34	Ceramic feedthru, 6.8pF ±10% 500V	CF-102-R68	A-B	FA5C	4
21	Ceramic disc, .001uF ±20% 1kV	CD-102-210	SPR	5GA-D10	1
22	Ceramic disc, 360pF ±20% 1kV	CD-102-136	SPR	5GA-T36	1
23	Ceramic disc, .005uF ±20% 100V	CD-103-250	SPR	TG-D50	1
24	Ceramic disc, 47pF ±5% 1kV	CD-104-047	SPR	10TCU-Q47	1
26	Ceramic disc, 120pF ±20% 1kV	CD-102-112	SPR	5GA-T12	1
"J "	CONNECTORS				
1,2	Jack, receptacle, 50ohm submin.	JF-000-005	APL	27-9	2
"CR "	DIODES				
1,2,3	Silicon, P.I.N.	DP-000-050	W-I	DP-000-050	3
4,5	Voltage variable capacitance	DC-000-008	W-I	DC-000-008	2
6,7	Voltage variable capacitance	DC-000-005	W-I	DC-000-005	2
8	Silicon, hot carrier	DG-000-007	H-P	5082-2800	1
9	Silicon, junction, 100piV 750mA	DR-000-001	ITT	1N4002	1
"L "	INDUCTORS				
1,2	Fixed ----	Not Assign.	W-I	-----------	2
3,4,9,11,12, 13,14	Fixed ----	LA-006-010	W-I	LA-006-010	7
5,6,7,8,10	Fixed ----	LA-006-005	W-I	LA-006-005	5
15	Fixed, 10mH	LA-004-310	JEF	15S103K	1
"R "	RESISTORS				
1,4,11,26	Fixed,comp., 47ohm ±10% ¼W	RC-104-047	A-B	CB4701	4
2	Fixed, comp., 330ohm ±10% ¼W	RC-104-133	A-B	CB3311	1
3,33,45	Fixed, comp., 1kohm ±10% ¼W	RC-104-210	A-B	CB1021	3
5	Fixed, comp., 150ohm ±10% ¼W	RC-104-115	A-B	CB1511	1
6,14,17,22, 25	Fixed, comp., 10ohm ±5% ¼W	RC-103-010	A-B	CB1005	5
7,9 ,52	Fixed, comp., 100ohm ±10% ¼W	RC-104-110	A-B	CB1011	3
8,10	Fixed, comp., 470ohm ±10% ¼W	RC-104-147	A-B	CB4711	2
12,21	Fixed, comp., 27ohm ±10% ¼W	RC-104-027	A-B	CB2701	2
13	Fixed, comp., 470ohm ±5% ¼W	RC-103-010	A-B	CB4715	1
15,19,20	Fixed, comp., 82ohm ±5% ¼W	RC-103-082	A-B	CB8205	3
16	Fixed, comp., 1.5kohm ±5% ¼W	RC-103-215	A-B	CB1525	1

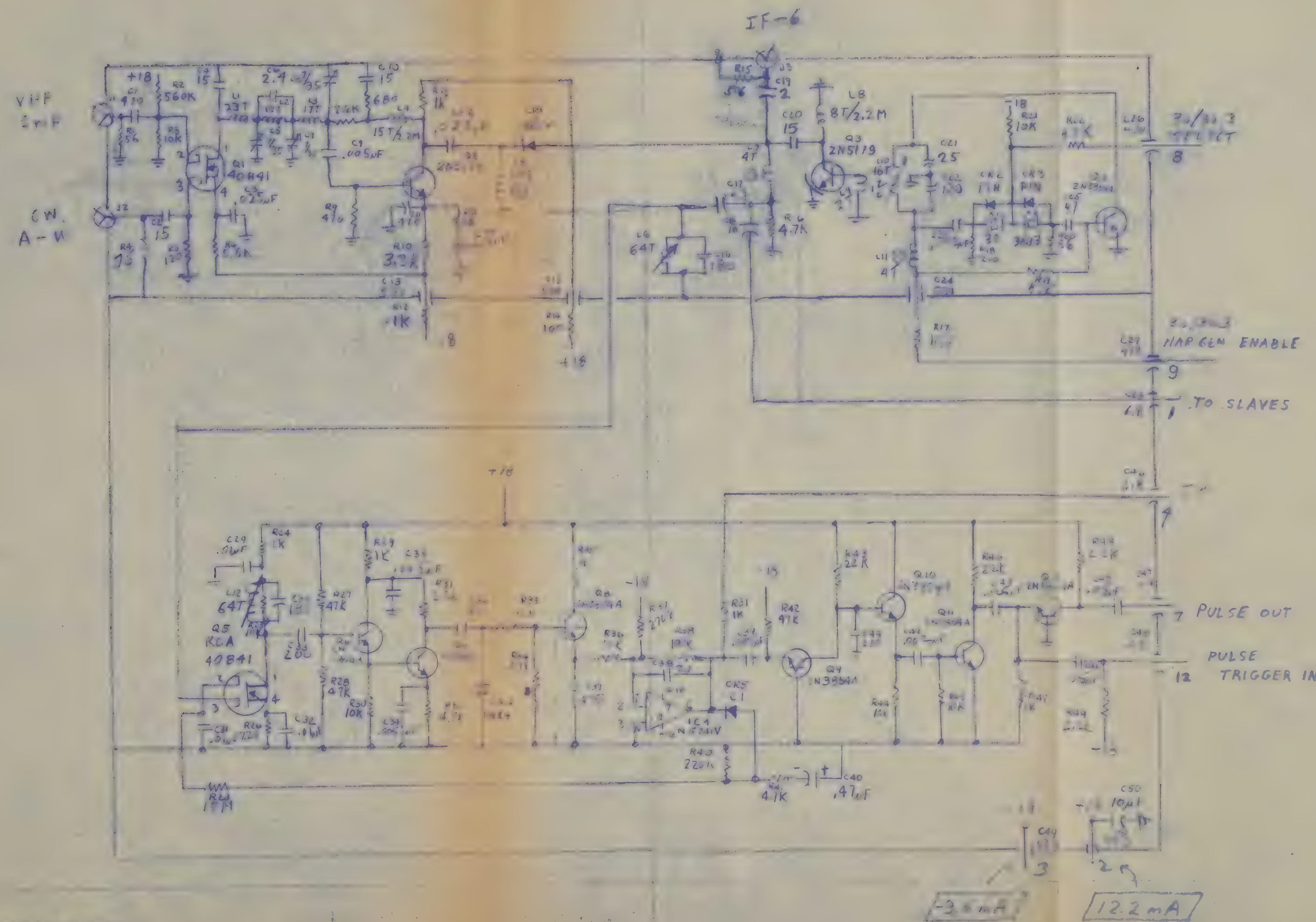
PARTS LIST

MODULE M10F M10G REV C

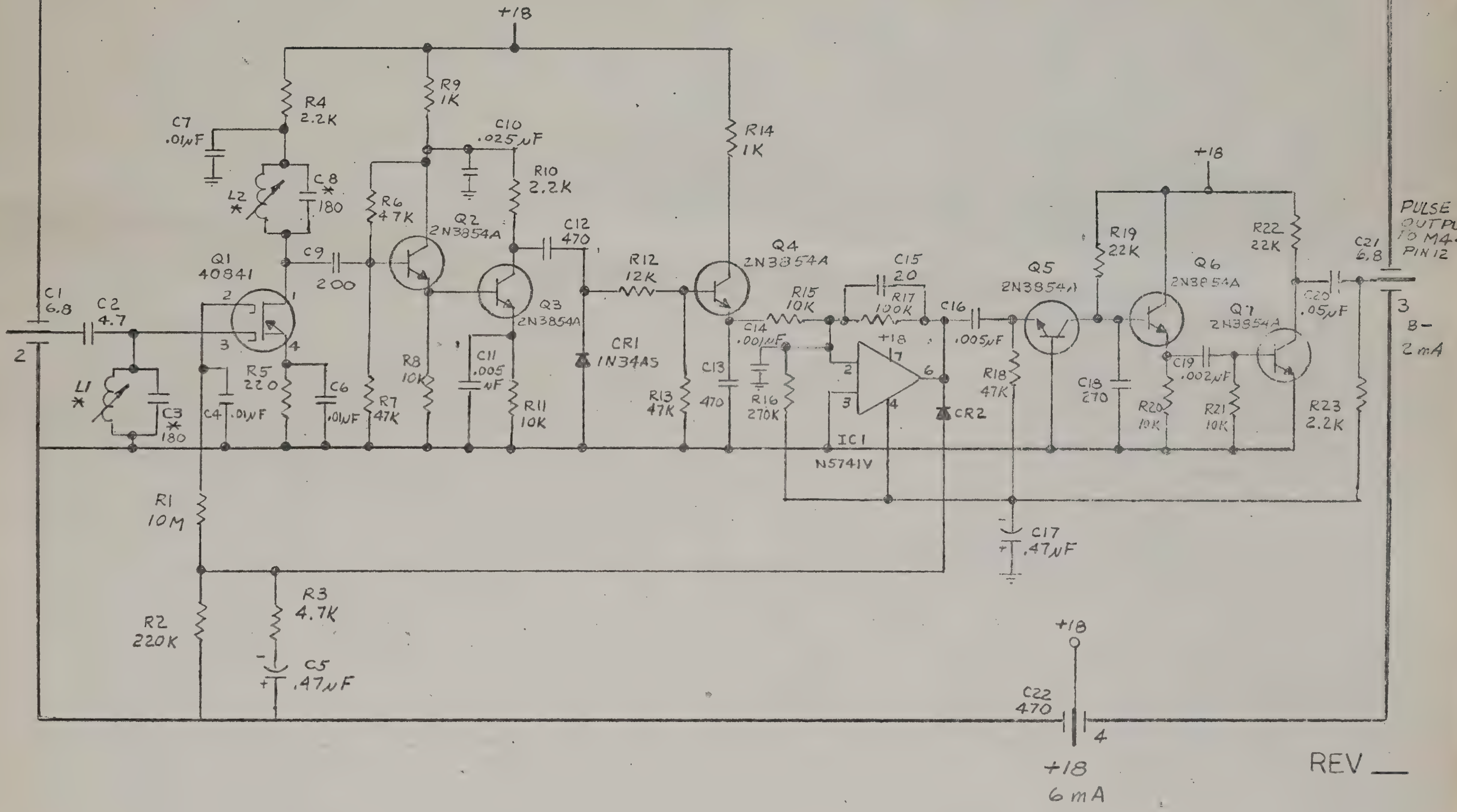
REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"R "	RESISTORS				
18	Fixed, comp., 22ohm ±10% ¼W	RC-104-022	A-B	CB2201	1
23	Fixed, comp., 360ohm ±5% ½W	RC-105-136	A-B	EB3615	1
24	Fixed, comp., 150ohm ±5% 1W	RC-107-115	A-B	GB1515	1
27	Fixed, comp., 39kohm ±10% ¼W	RC-104-339	A-B	CB3931	1
28,30	Fixed, comp., 33kohm ±10% ¼W	RC-104-333	A-B	CB3331	2
29	Fixed, comp., 120ohm ±5% ½W	Rc-107-112	A-B	GB1215	1
31	Fixed, comp., 47ohm ±5% ¼W	RC-103-047	A-B	CB4705	1
32	Fixed, comp., 82ohm ±10% ¼W	RC-104-082	A-B	CB8201	1
34,38,46	Fixed, comp., 10kohm ±10% ¼W	RC-104-310	A-B	CB1031	3
35	Fixed, comp., 1Mohm ±10% ¼W	RC-104-510	A-B	CB1051	1
36	Fixed, comp., 2.2Mohm ±10% ¼W	RC-104-522	A-B	CB2251	1
37,39	Variable, carbon, 20kohm ±20% ¼W	RP-124-320	A-B	WA2G032	2
40,42	Fixed, comp., 270kohm ±10% ¼W	RC-104-427	A-B	CB2741	2
41	Fixed, comp., 1.2kohm ±10% ¼W	RC-104-212	A-B	CB1221	1
43	Fixed, comp., 2.7kohm ±10% ¼W	RC-104-227	A-B	CB2721	1
44,50	Fixed, comp., 4.7kohm ±10% ¼W	RC-104-247	A-B	CB4721	2
47	Fixed, comp., 820kohm ±10% ¼W	RC-104-482	A-B	CB8241	1
48	Fixed, comp., 47kohm ±10% ¼W	RC-104-347	A-B	CB4731	1
49,51	Fixed, comp., 220ohm ±10% ¼W	RC-104-122	A-B	CB2211	2
"Q "	TRANSISTORS				
1,2,4	NPN, Silicon	QB-000-013	AER	A430	3
3,5,6	NPN, Silicon	QB-000-018	SSS	SD 1006	3
7	N-channel, JFET, Silicon	QA-054-580	MOT	2N5458	1
8	NPN, Silicon, dual	QB-000-010	SPR	TD101	1
9,10	PNP, Silicon	QB-000-009	MOT	MPS3702	2

REV 11/14/72

8/22/72



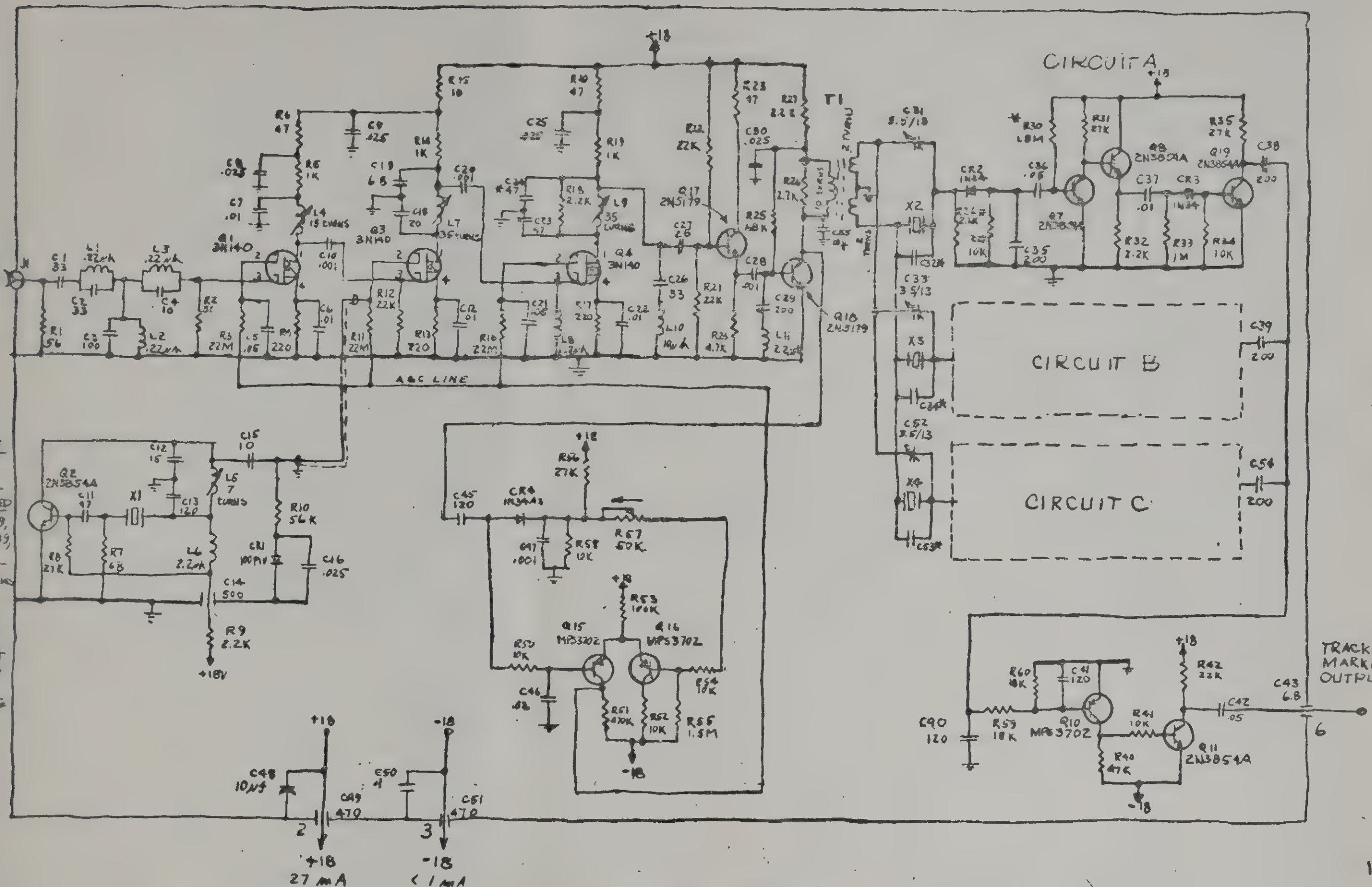
HIGHEST CIRCUIT REFERENCE USED



REV __

ADDITIONAL RF MARKERS

MODULE M6P



HIGHEST CKT REF.
C54, CR4, L11
Q19, R60

CKT REF. NOT USED
C35, Q5, 6, 9,
12-14, R36-39,
43-49

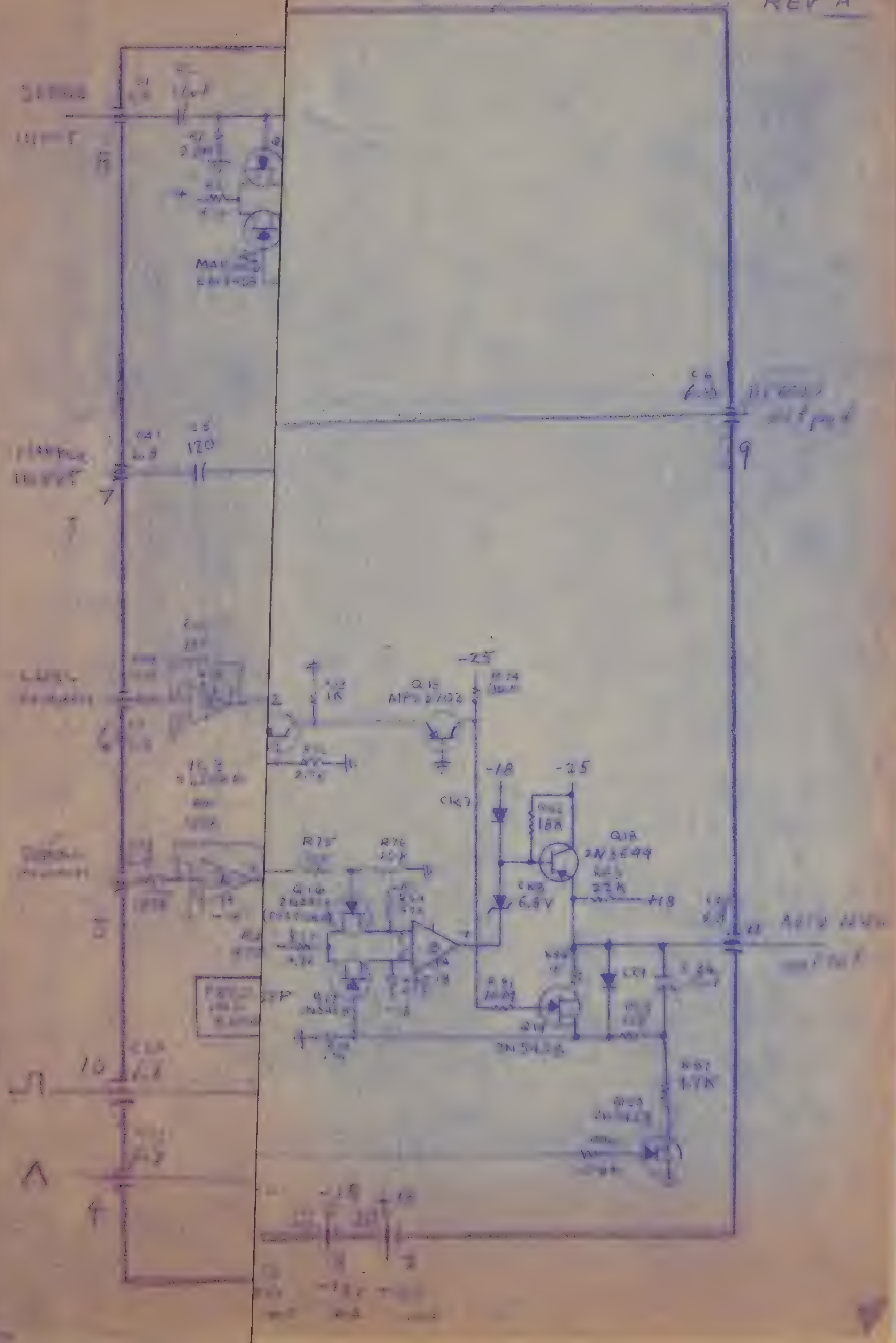
CAPACITANCE VALUES < 1 IN MF EXCEPT AS NOTED.
1 & GREATER IN PF. EXCEPT AS NOTED

* FACTOR: ADJUSTABLE

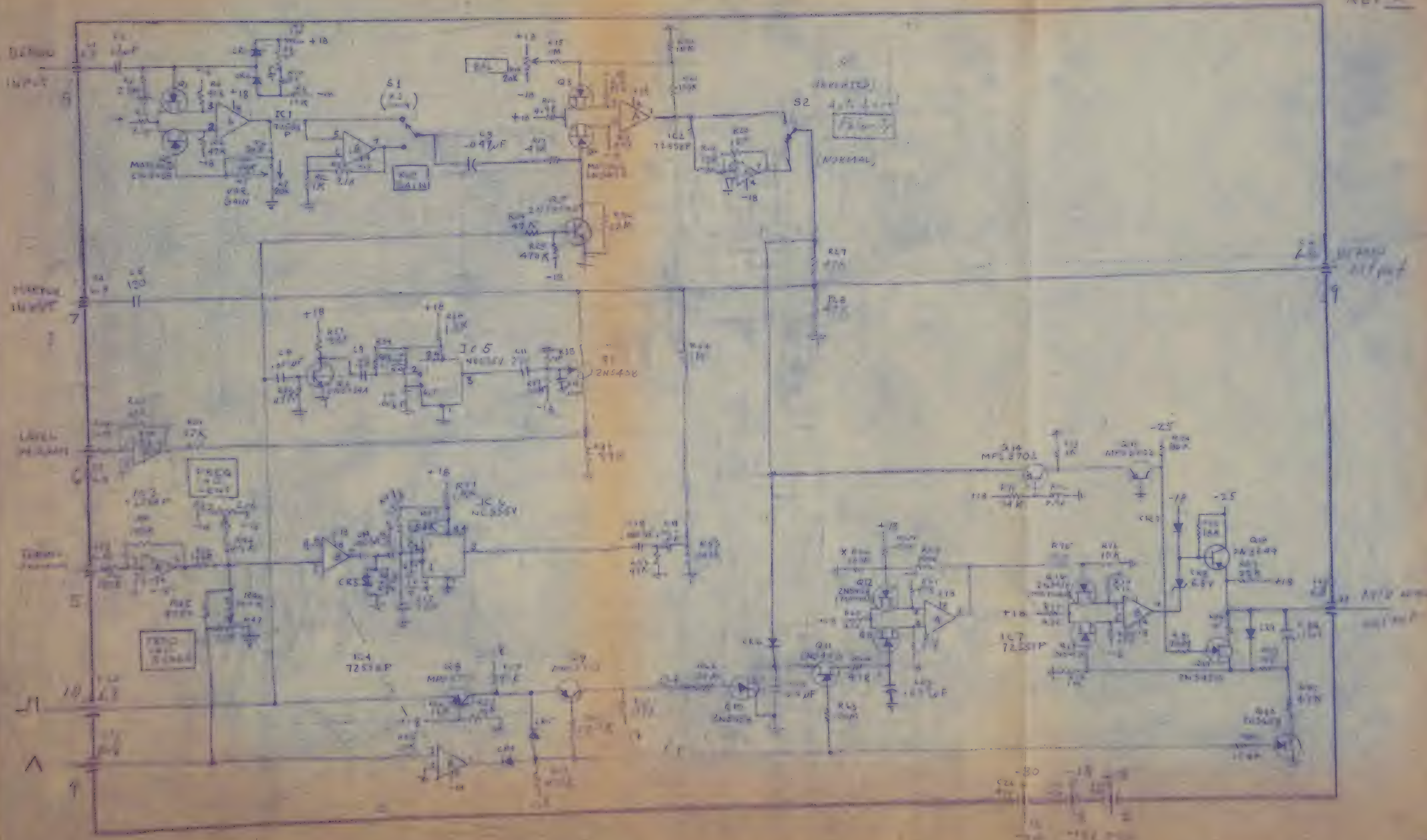
ECN # 3
L8 w .22uH

PTION C , MODULE MBE

REV A

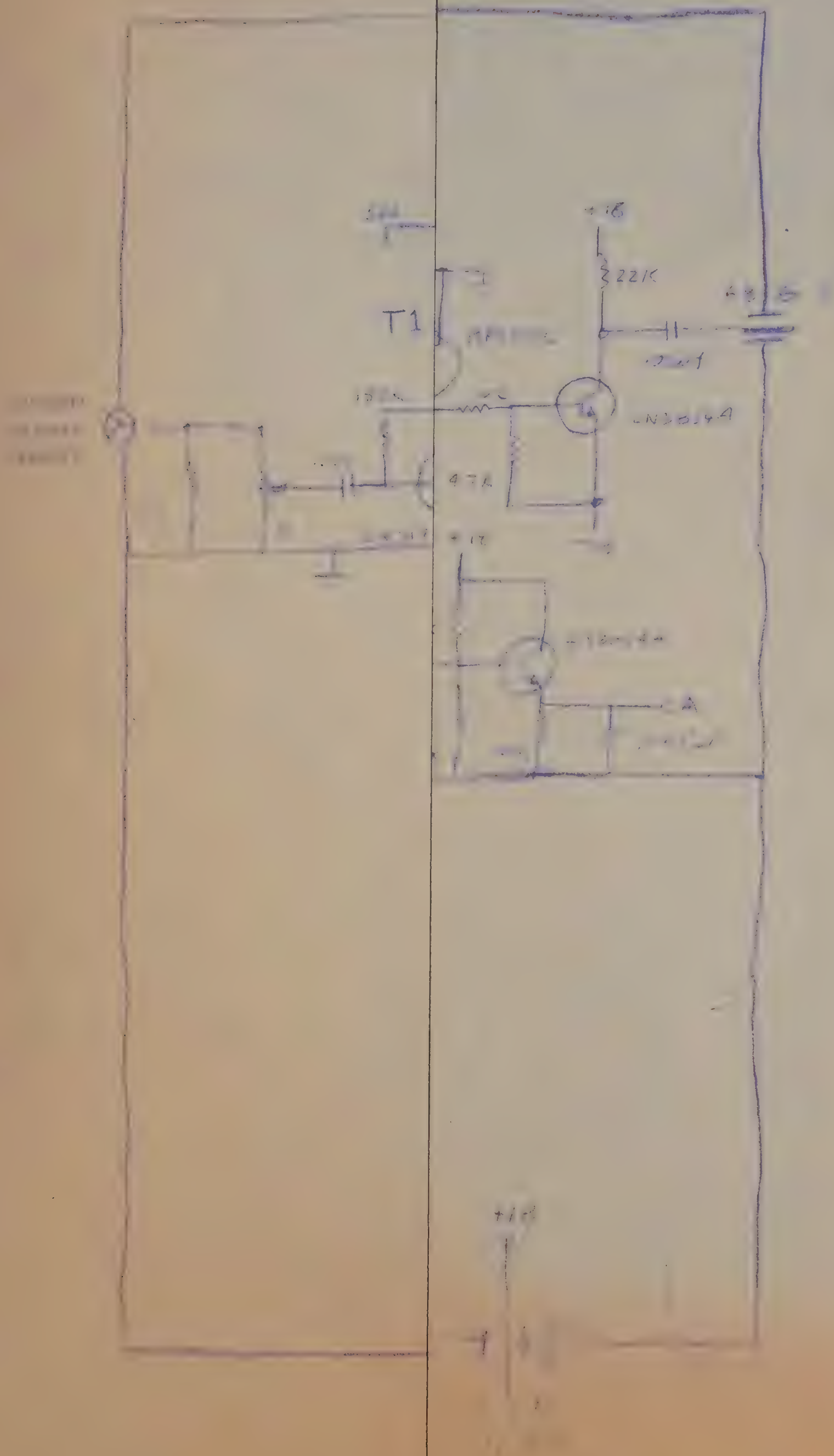


AUTOMATIC LEVEL & SCOPE INDICATOR SCHEMATIC,
OPTION C , MODULE M8E REV A



I F MARKER SCHEMATIC
MODULE M13H

REV ___



I F MARKER SCHEMATIC
MODULE M13H

REV ___